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ELEMENTS OF ANATOMY.

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ELEMENTS OF ANATOMY.

BY

JONES QUAIN, M.D.

" Pour connaitre homme malade, il faut connaitre homme sain."—CABANIS.

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PREFACE

TO

THE FOURTH EDITION.

THE details of Anatomy are so numerous, and the relations which different textures and organs bear to one another are so various, that it can scarcely be expected of students to retain them all in memory, or to form correct ideas of them from merely reading their description. The objects themselves must be referred to, in order that their structure and properties should be rightly understood. As this, however, cannot at all times be done, much assistance is derived from a reference to correct sketches or drawings. To facilitate the progress of the student, I have introduced into the present edition of this work a number of drawings, which it is hoped will suffice, not only for the purpose of illustration, but will also be of use in the dissecting-room, by supplying views of the leading objects, such as muscles, vessels, nerves, &c. which are there examined from day to day, their names and relations being fully stated. The methods of bringing into view the objects delineated, will at the same time be found sufficiently detailed in the remarks on dissection in the different portions of the work.

For the illustrations I am indebted to Mr. W. J. E. Wilson. The preparations from which the drawings in the first two plates are taken were altogether made by him; he likewise directed their execution, as well as the various sketches for the wood-cuts throughout the book. While I make my acknowledgment for much assistance and kindness received from my friend, the works will, I believe, sufficiently speak for themselves.

The drawings are due to the pencil of Mr. William Bagg. They are taken in most instances from preparations and dissections made expressly for the work; the engraving has been conducted with great care by Mr. Bagg, sen.

TO THE READER.

It has been remarked by one* who thought deeply, and observed accurately, " that the best order in which truth can be set forth is that in which it might naturally have been discovered; and that the most attractive method of instructing others is to lead them along the path which we ourselves have followed in our own instruction; for in this way we seem not so much to place before them our own knowledge as to set themselves in the search of truth." Continuing the train of the thought suggested by the observation here cited, we may add, that if it be expedient to keep these objects in view in the conduct of courses of oral lectures addressed to youth, it is at least equally so in the composition of works written for their instruction.

This elementary work, the fourth edition of which is now presented to the public, is intended to serve as a guide and a key to the study of Anatomy. It sets forth the various facts usually included within the limits of the subject of which it treats,—points out the more important principles which follow from them,—indicates the most compendious methods of arriving at a knowledge of the one, and traces some of the practical applications which should be made of the other.

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* Condillac.

A correct knowledge of the structure of the human body is confessedly necessary to a right understanding of the principles of Medicine as well as of Surgery. It should, however, be observed, that the method of study and investigation varies, according as it is undertaken in reference to the one or the other; for, although the principle of analysis guides us in each, the mode of conducting it is different. Thus, when we examine the structure of an organ previously to undertaking the investigation of its functions and diseases, we resolve it into the elementary textures of which it is composed, in order to study the characters and composition—the physical and vital properties of each texture, separately, as a preliminary measure to the examination of them in their combined state in the organs which they make up. This mode of considering the parts of organised bodies is not an unnatural abstraction, or a speculative refinement; it arises from the nature of their composition, and is founded on the most approved principles of philosophical investigation. It forms the basis of that department which has been, since Bichât's time, called General Anatomy; it may, perhaps, with more propriety be named "Structural, or Analytical Anatomy." An outline of the leading facts and principles included within its limits will be found in the first chapter of this work; its practical application may be exemplified by a reference to the use which has been made of it in the study of the diseases of the different viscera —for instance, the lungs. We find these organs invested externally by a serous, and lined internally by a mucous membrane, which pervades the bronchial tubes, even to their ultimate termination in the air-cells. If we could just imagine the one to be drawn out from the interior, and the other peeled off from the outside, we should leave insulated what the older anatomists termed the parenchyma of the organ. Now, observation has shown that either of these three component parts may be inflamed separately, the others remaining unaffected ; and pathologists have marked the inflamed condition of these textures by distinct names, the one being called pleuritis, the other bronchitis, the third pneumonia. The serous membrane when inflamed will present a certain set of characters, will go through a series of changes, and exhibit a train of phenomena in its anatomical characters and in the symptoms which supervene, as widely different from those presented by the mucous membrane under similar circumstances, as if these textures did not belong to the same organ. But, if we examine the progress of inflammation in the peritonæum, in the arachnoid membrane, or in the serous lamella of the pericardium, and compare its characters and symptoms with those presented by the pleura, we shall find the most striking similitude, though these membranes are placed in different cavities, and enter into the composition of organs which perform distinct functions. As, in consequence of their striking similarity in structure, properties, and anatomical characters, these membranes are ranged under one head, and form one class, so their diseases should also form one group ; on the obvious principle, that the closer the similitude between parts in their structure, functions, and characters during health, the more nearly will they resemble one another in the changes induced by disease.

These considerations at once point out the necessity of applying the principle of analysis, aided by experiment and observation, to the study of Anatomy; they indicate also a mode of arranging diseases according to a natural method, by grouping them together according to their mutual affinities, and thereby introducing into medicine those rigorous methods of investigation which have already effected so much for other departments of natural science.

When the structure of the body is investigated in reference to practical Surgery, a different method is pursued. The body is considered as divisible, not into elementary textures, but into separate regions, or compartments, each requiring a special degree of attention, inasmuch as it may become the seat of a disease, or the subject of an accident, requiring an operation for its relief. Anatomy studied in this way becomes a sort of topography, as it includes a consideration of the extent and boundaries of each region, and of the lines and ridges which intersect it, at the same time that they serve as so many landmarks to guide the steps of those who explore it. But attention is not to be confined to the surface of things; the anatomist dips beneath it, and scrutinises the form, size, and structure of the different lamellæ which lie, layer after layer, one upon another, filling up the interval between the skin and the solid substratum, the bone. Each part is thus seen in its natural position, and every circumstance is taken into account which can influence the choice of one operation rather than another, as well as the method of executing every step of the operation which is selected. These views and objects were constantly present to my mind whilst I was engaged in writing the sections which treat of the anatomy of the neck, —of the bend of the arm and of the knee,—of the axillary and inguinal regions, as also of the perinæum.

I should recommend the student to commence his pursuits by acquiring some knowledge of the primary tissues or textures of which the body is composed, inasmuch as they constitute its anatomical elements. He can readily procure specimens of membrane, ligament, tendon, muscle, nerve, artery, vein, and gland, and examine their characters and properties, so as to be able to distinguish them, particularly if at the same time he reads the sections which treat of them. In the next place, after having inspected the skeleton and noted the general arrangement of its component parts, he should proceed with the examination of its different pieces, beginning with the spine. When reading the description of the bones, he should have a specimen of each before him. It is usual, as a matter of convenience, to examine the ligaments after the muscles.

The first essays in dissection are usually made in order to learn the anatomy of the muscular system. If the reader opens the book at page 286, he will find in a note at the bottom some suggestions as to the order in which the dissection of the different groups of muscles contained in the part allotted to him should be conducted; and at the conclusion of the fourth chapter, page 443, a tabular view is given of all the muscles of the body, arranged in the order of dissection. When he turns to the section which treats of each group, he will find the individuals composing it enumerated in the first instance, and then the method indicated of exhibiting them by dissection, so as to bring them clearly into view. The detailed description of each follows; and, lastly, comes the account of their actions and uses.

The plan of proceeding here indicated is adhered to throughout the work: for instance, the muscles of the orbit are named; the mode of sawing through the bones in order to expose them is stated; in the next place the description of the muscles is given, and this is followed by the rationale of their actions. In a subsequent section, when treating of the globe or ball of the eye, its components are stated, and the methods of exhibiting them by different sections pointed out, —how it should be fixed whilst making the incisions, and how the membranes should be separated in order to obtain a clear view of each.

The description of the different orders of vessels—of the nerves, and the viscera, follows in regular order, each being treated in nearly the same way.

The student is not to suppose, that whilst examining the muscles of the body he is engaged in learning mere anatomical details, or that he is doing no more than collecting such facts as are necessary to enable him to understand the phenomena of muscular action. It is confessedly interesting to know the mechanism of the movements which the different sets of muscles can execute, and trace the nice adaptation of the various parts which are engaged in their performance. Almost every inquiring person feels a desire to know wherein consists the faculty we possess of accurately fixing the hand and fingers on the minutest objects — of turning the axis of the eye to every point within our field of vision — and of giving to the vocal cords the different degrees of tension and relaxation necessary to produce all the varieties of tone of which the voice is susceptible, and of combining at the same time the efforts of a great number of muscles, so as to impress upon it all that precision of modulation which is attainable both in singing and speaking. But our inquiries are not confined to these points; their value becomes considerably enhanced when we learn the practical applications to which they lead, and perceive that, whilst apparently engaged in learning the structure and actions of muscles, we are really studying two most important chapters in practical surgery, namely, those on dislocations and fractures. The muscles being the moving powers in all the efforts which our limbs perform, they become the controlling agents in the new circumstances in which bones are placed when dislocated. A knowledge of their several actions in their natural state will readily enable us to determine how to overcome the resistance of some, and avail ourselves of the co-operation of others, during our efforts to replace the bone. And in cases of fracture, we can regulate the position of the limb in such a way as to relax the muscles, and prevent their displacing the broken pieces after they have been adjusted.

The viscera, or, as they are usually named, the internal organs of the body, as being so many instruments for the performance of special purposes, are arranged according to their functions. These are divisible into two classes, of which one is intended for the support and well-being of the individual, and the other for the continuance of the species.

- Functions for the well-being of the individual.
  - Functions of Nutrition.
    - Digestion.
    - Absorption.
    - Respiration.
    - Circulation.
    - Assimilation.
    - Secretion.
    - Innervation.
  - Functions of Relation.
    - Sensation.
    - Intellectual faculties.
    - Muscular movements.
    - Expression (gesture, speech).
- Functions for the continuance of the species.
  - Conception.
  - Developement of the embryo, &c.

These different topics necessarily involve a great variety of facts and of inferences; so much so, that if the study of them be not conducted with method, the mind would become oppressed by a load of detail, and would be repelled from the pursuit by its complexity, instead of feeling an interest awakened by the nature of the inquiries which it every moment suggests.

What, then, is the proper method of study? The objects of study, from their very nature, must present themselves in different points of view, and require different methods of investigation. Thus you may consider the situation, form, and size of a given organ, and then its relations to contiguous parts. When you have stated all the facts relative to these points, you have given a description of the part, inasmuch as you have followed the *descriptive method;*

and this is all that is usually done in works on Descriptive Anatomy; they give merely the topography of parts. It must be obvious that it is not sufficient for our purposes thus to confine attention to the surface of things; our inquiries are not to be limited to external forms, or mere relations of place. We desire to become acquainted with the composition and structure of the human frame, or, in other words, with the elements of which it is made up. With this view, we resolve it into its constituents, and then examine the character and properties of each of these separately, as a necessary preliminary to a just appreciation of their powers when combined. This is the *analytical method.* Its application and use have been already pointed out in the remarks on General Anatomy.

As the phenomena included in a particular function, or in the derangement of it, do not present themselves to us at once, but occur in succession, it becomes necessary not merely to enumerate them, but to set them down in the exact order of their occurrence. When treating of the digestive function, for instance, we have to consider the mechanism employed in the prehension and mastication of food, its impregnation with saliva, its deglutition and conveyance to the stomach, the changes which the mass undergoes in that viscus, and afterwards successively, as it passes, step by step, through the different parts of the alimentary canal. When these particulars are fully stated, the narrative is complete, and we have conformed to what is termed the *historical method.*

We cannot, however, confine ourselves to a mere statement of facts, or an enumeration of events. The very constitution of our minds compels us to draw inferences from the facts we have observed: we cannot help thinking, and to think is to theorise. This we at once recognise as the starting-place of all the speculative views and visionary opinions which the history of medicine records; and, unhappily, they are but too numerous: some of them evidently flow from the disposition so constantly manifested to deduce general principles from inadequate data; others are referable to that proneness which persons evince, when entering on speculations concerning the phenomena of life and the functions of living beings, to carry with them and even rigorously apply, notions and principles taken from such pursuits as had previously, and perhaps exclusively, engaged their attention. Hence it is that the Philosophers of old introduced into medicine their peculiar hypotheses, and the Heathen priests tinctured it with their superstitious rites; whilst, in more modern times, the Mechanists sought to explain the functions of the body in health, and its derangements in disease, by principles deduced from hydraulics, and the Chemists referred them to the affinities which govern the processes they were wont to observe in their laboratories.

" From whence," said Bacon, when discoursing of the speculative systems which obtained in another department of science,—" from whence can arise such vagueness and sterility in all the physical systems which have hitherto existed in the world? It is not certainly from any thing in nature itself, for the steadiness and regularity of the laws by which it is governed clearly mark them out as objects of certain and precise knowledge; neither can it arise from any want of ability in those who have pursued such inquiries, many of them having been men of the highest talent and genius of the ages in which they lived: it can arise from nothing else than the perverseness and insufficiency of the methods that have been pursued. Men have sought to make a world from their own conceptions, and to draw from their own minds all the materials they employed; but if, instead of doing so, they had consulted experience and observation, they would have had facts, not opinions, to reason upon, and might have ultimately arrived at a knowledge of the laws which govern the material world. As things are conducted at present, a sudden transition is made from sensible objects and particular facts to general propositions, which are accounted principles, round which, as round so many fixed poles, disputation and argument continually revolve. From propositions thus hastily assumed, all things are derived by a process compendious and precipitate, ill suited to discovery, but wonderfully accommodated to debate. The way that promises success is the reverse of this. IT REQUIRES THAT WE SHOULD GENERALISE SLOWLY, GOING FROM PARTICULAR THINGS TO THOSE WHICH ARE BUT ONE STEP MORE GENERAL, AND FROM THESE TO OTHERS OF STILL GREATER EXTENT, AND SO ON TO SUCH AS ARE UNIVERSAL. By such means we may hope to arrive at principles not vague and obscure, but luminous and well defined, such as Nature herself will not refuse to acknowledge."*

This is the *inductive method,* as taught by Bacon.

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* Novum Organum.

To observe patiently, experiment cautiously, and generalise slowly, are the precepts it enjoins for the guidance of our own researches, and the tests which it suggests for estimating the value of the opinions and researches of others. The bias of prepossession and the influence of authority have for too long a time led away the mind from a conformity with its precepts: but happily these disturbing causes have now nearly passed away; for in our schools no general theory is taught—no uncompromising dogma is inculcated—no individual, however eminent he may be, can draw after him a crowd of followers ready to take his dictum as law, and resolved, when they set forward in life, to make their practice square with his injunctions; in a word, there no longer exists a monarchy in medicine; and, were we to look back to the history of those times in which the men of that profession were little else than the obsequious followers of a few distinguished individuals, we should find little reason to regret that their influence is at an end. And let not this excite surprise or regret—it should rather be a ground of satisfaction and gratulation, inasmuch as it has arisen, not from any causes tending to depress the few, but from the wide spread of knowledge, which has tended to elevate the many. There never was a period in the history of medicine in which there was less to discourage inquiry than the present — there never was a time in which so many circumstances conspired to invite a scrutiny into all its departments. The mind is no longer prostrated by the domination of authority, nor is reason warped by the influence of system. The errors of preceding inquirers are so many beacons to warn those who succeed from straying into the devious tracks into which they wandered, and the failure of their methods of investigation points to the necessity of pursuing a different line of research from that which they adopted. Speculation and hypothesis have reigned too long; it has been too much the practice of system-makers to construct their edifices, if I may so say, "from their own conceptions, and to draw from their own minds all the materials they employed." Whilst notoriety, perhaps even distinction, could be attained by such compendious methods, we cannot feel surprise at the number of hypotheses which the history of medicine records, or at the fleeting credit they maintained. One heresy gave way to another, and a third succeeded, as short-lived as either of its predecessors. But, even at the present day, it is not a little difficult to repress speculation altogether, and confine inquiry within its legitimate bounds.

We constantly speak of the functions and powers of organs,—of the properties and qualities of different substances,—of the causes of diseases,—of the effects of remedies; yet how few are there amongst us who attentively consider the exact meaning of the words cause and effect, power and function, property and quality! Yet no class of men ought to be more precise and rigorous in the employment of them than the members of the medical profession. At the very outset of his pursuits, every student should know in what consists the relation of "cause and effect," and should be able clearly to perceive what it is that gives to one event or phenomenon the implied prerogative of "cause," and places the other in what is usually considered the subserviency of "effect."

"A cause," to use the words of Dr. Brown,* "may be said to be that which immediately precedes any change, and which, existing at any time in similar circumstances, has been always, and will be always, immediately followed by a similar change. Priority in the sequence observed, and in variableness of antecedence in the past and future sequences supposed, are the elements, and the only elements, combined in the notion of a cause. By a conversion of terms, we obtain a definition of the correlative *effect*; and *power*, as I have before said, is only another word for expressing briefly the antecedence itself, and the invariableness of the relation.

* * * *

"It is this mere relation of uniform antecedence, so important and so universally believed, which appears to me to constitute all that can be philosophically meant in the words *power* or *causation*, to whatever objects, material or spiritual, the words may be applied. If events had succeeded each other in perfect irregularity, such terms never would have been invented; but, when the successions are believed to be in regular order, the importance of this regularity to all our wishes, and plans, and actions, has, of course, led to the employment of terms significant of the most valuable distinctions which we are physically able to make. We give the name of *cause* to the object which we believe to be the invariable antecedent of a particular change; we give the name of *effect* reciprocally to that invariable consequent; and the relation itself, when considered abstractedly, we denominate *power* in the object that is the invariable antecedent—*susceptibility* in the object that exhibits, in its change, the invariable consequent. We say of fire, that it has the *power* of melting metals; and of metals, that they are *susceptible* of fusion by fire,—that fire is the *cause* of the fusion, and the fusion the *effect* of the application of fire; but, in all this variety of words, we mean nothing more than our belief, that when a solid metal is subjected for a certain time to the application of a strong heat, it will begin afterwards to exist in that different state which is termed liquidity; that, in all past time, in the same circumstances, it would have exhibited the same change; and that it will continue to do so, in the same circumstances, in all future time. We speak of two appearances which metals present; one before the application of fire, and the other after it: and a simple but universal relation of heat and the metallic substances, with respect to these two appearances, is all that is expressed. * * * *

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* Inquiry into the Relation of Cause and Effect.

"The words *property* and *quality* admit of exactly the same definition; expressing only a certain relation of invariable antecedence and consequence, in changes that take place on the presence of the substance to which they are ascribed. They are strictly synonymous with *power;* or, at least, the only difference is, that *property* and *quality,* as commonly used, comprehend both the *powers* and *susceptibilities* of substances,—the powers of producing changes, and the susceptibilities of being changed. We say equally that it is a property or quality of water to melt salt, and that it is one of its qualities or properties to freeze or become solid on the subtraction of a certain quantity of heat; but we do not commonly use the word *power* in the latter of these cases, and say that water has the power of being frozen. . . . *Power, property*, and *quality*, are, in the physical use of these terms, exactly synonymous. Water has the *power* of melting salt; it is a *property* of water to melt salt; it is a *quality* of water to melt salt. All these varieties of expression signify precisely the same thing, that, when water is poured upon salt, the solid will take the form of a liquid, and its particles be diffused in continued combination through the mass. Two parts of a sequence of physical events are before our mind; the addition of water to salt, and the consequent liquefaction of what was before a crystalline solid. When we speak of all the powers of a body, we consider it as existing in a variety of circumstances, and consider, at the same time, all the changes that are or may be, in these circumstances, its immediate effects. When we speak of all the qualities of a body, or all its properties, we mean nothing more, and we mean nothing less. Certain substances are conceived by us, and certain changes that take place in them, which we believe will be uniformly the same, as often as the substances of which we speak exist in circumstances that are exactly the same.

"The powers, properties, or qualities of a substance are not to be regarded, then, as anything superadded to the substance, or distinct from it. They are only the substance itself, considered in relation to various changes that take place when it exists in peculiar circumstances."

The doctrine of cause and effect as here given, in the words of the most recent and generally approved writer on the subject, points to the necessity of being careful to place facts and phenomena in the exact order of their occurrence, with a view to determine the invariable antecedent to any event the cause of which we seek to ascertain. So far it suffices for the purpose for which it has been introduced in this place. But, though invariably antecedence is a necessary ingredient in causation, there is no sufficient reason for contending that it constitutes its sole essence. We cannot divest ourselves of the impression that there is some connexion between the consequent and antecedent, more effective than that which is implied in mere sequence. When I remove the inkstand before me from one part of the table to another, or push the table on which I write from one side of the room to the opposite, I am conscious of an effort, and of the possession of a power to produce the removal in both cases. Hence, when I observe any marked change or particular result, I infer the existence of some power or influence which has been exerted to produce it. When vomiting follows the administration of a few grains of emetic tartar—when an intermittent fever ceases after a dose of quinine, we cannot but ascribe to these substances some quality or property from the influence of which the results follow.

It will be asked, Is there anything so recondite in medicine as to require an attention to the principles of the inductive philosophy? Or, is it to be supposed that, when hearing the report of a case, and resolving upon a plan for its treatment, we are to make an application to the doctrine of cause and effect? Is not medicine a science of observation? Cannot we use our eyes and ears, observe what is presented to us, and then follow the dictates of common sense? Certainly. But, be it remembered (to use the words of Cullen in his oral lectures, as quoted by Mr. Macculloch,) that "to observe accurately requires a freedom from prejudice and an acuteness that belong to few. Many circumstances tend to vitiate statements dignified with the name of experience. The simplest narrative of a case almost always involves some theories. It has been supposed that a statement is most likely to consist of unsophisticated facts when reported by a person of no education: but it will be found an invariable rule, that the lower you descend in the medical profession, the more hypothetical are the prevailing notions. Again, how seldom is it possible for any case, however minutely related, to include all the circumstances with which the event was connected. Hence, in what is commonly called experience, we have only a rule transferred from a case imperfectly known to one of which we are equally ignorant. Hence that most fertile source of error, the applying inferences deduced from one case to another case, the circumstances of which are not precisely similar. WITHOUT PRINCIPLES DEDUCED FROM ANALYTICAL REASONING, EXPERIENCE IS A USELESS AND BLIND GUIDE."

In page 13 the reader will find a list of the most approved systematic treatises on general and descriptive anatomy. Besides these, the following monograph works and detached essays will be found cited or referred to, either in the text or in foot-notes of this volume, and may be consulted by those who wish for fuller information on the subjects of which they

treat, than can be conveniently brought within the limits of an elementary treatise.

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DESCRIPTION OF THE PLATES.

FIGURE 1. A piece of cellular tissue, prepared so as to show its structure:—*a,* the cellules and the lamellæ which enclose them; *b, b,* some of the cellules laid open.

FIG. 2. A piece of adipose substance:—*c,* the exterior or enclosing cellules — their membranous parietes; *d,* a nutrient vessel ramifying amongst these; *e,* a single adipose vesicle as represented by M. Raspail.

FIG. 3. A portion of bone and its investing membrane:—*f,* the bone; *g,* the periosteum.

FIG. 4. A piece of corium, showing the appearance which its external surface presents when examined with a microscope:—*h,* the ridges or raised lines in which the papillæ are disposed in rows; *i,* the furrows between the lines, and called "interlinear," to distinguish them from those which intersect them, *k,* and which are named "interpapillar," as they are interposed between the papillæ.

FIG. 5. A single row of papillæ viewed in profile as they project from the corium.

FIG. 6. A diagram representing the position and relations of the three layers of which the common external tegument is composed,—the corium is shown connected to the subjacent parts by cellular and adipose substance; the papillæ which project from its outer surface are covered by the rete mucosum and epidermis, which, from their plastic nature, are as it were moulded upon them.

FIG. 7. A piece of corium, with the rete mucosum and cuticle raised so as to show the sweat-ducts:—*l,* the interpapillar lines, which, when viewed at the inner surface of the raised rete and cuticle, represent ridges; *m,* the interlinear ridges; *n,* slight hollows or pits, into which the papillæ project; *o,* the corium with its papillæ and lines; *p,* the sweat-ducts emerging from the corium and piercing the rete and cuticle.

Fig. 8. A piece of cuticle, showing the raised lines and furrows on its external surface :—*q*, the raised lines ; *r*, the pores or orifices of the sweat-ducts. Fig. 8*. A piece of rete mucosum.

Fig. 9. A plexus of lymphatic vessels in the corium injected.

Fig. 10.—1. A sketch indicating the connexion of a hair with its papilla, and the three layers of the tegument.—2. *b*, The bulb of a hair ; *c*, the papilla.

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ELEMENTS OF ANATOMY.

INTRODUCTION.

1. **Anatomy**, (*ανατομη, dissection; ανατεμνω, to cut up*,) in its original and literal signification, meant dissection, or an artificial separation of parts. It required no more than a scalpel for its execution, and sufficed for all the purposes sought to be attained in the earlier periods of the history of medicine. But as the objects of pursuit became multiplied, the methods of examination were necessarily varied; and several other processes have been from time to time introduced, such as an injection, maceration, desiccation, chemical re-agents, &c. with a view to arrive at a more intimate knowledge of the composition and structure of the different parts of the body. Notwithstanding these changes, the same term is retained, and is allowed by general consent to include within its comprehension not only the means employed, but also the end which is sought to be attained. Hence it is that Anatomy is now considered synonymous with "Science of Organisation;" for it embraces all the varieties of organised bodies, and has for its object the study of their structure and properties, physical as well as vital. A science of such vast extent must necessarily comprise too great a variety of details to be adequately investigated by any single individual. Its progress and improvement up to the present time have been owing to the exertions of different persons devoting themselves each to a particular department of the pursuit; and if we may judge of the future by the past, it is not too much to say, that its further advancement must depend on a similar co-operation, conducted on the principle of the division of labour. Thus, some have applied themselves to the examination of the structure of plants, others to that of animals, whilst those engaged in the study of medicine have confined their attention to that of the human species; which

has given occasion to the formation of three distinct departments, viz. *vegetable*, *animal*, and *human*, anatomy.

2. The anatomy of plants, or Phytotomy, (*φυτον*, *a plant*, *τομη*, *cutting*,) has for its object to explain the composition of the vegetable tribes. Animal anatomy, or Zootomy, (*ζωον*, an *animal*, *τομη*,) is directed to investigate the structure of the lower animals. It is usually called Comparative Anatomy; for, whilst treating of the conformation and developement of the different organs and systems in each class and order of animals throughout the series, reference is constantly made to the corresponding parts in the human subject, which is taken as a general standard of comparison. Human anatomy is studied, not merely because it serves to explain the structure of the body, nor because it leads to a knowledge of the uses of its different parts, but because of the light which it sheds on the seat, nature, and causes of disease,—a light without which medicine would be little else than a blind empiricism. Anatomy is included amongst the natural sciences; so is zoology; but they differ altogether both in their plan and object: the latter dwells on the external form and characters of animals, and is cultivated for the most part with a view to ascertain, by an examination of the different classes and orders, the characters common to all, as well as those peculiar to each, and thereby to establish a methodical arrangement of them founded on their natural affinities; the former, on the contrary, seeks to explore their interior, and resolves them into their component parts, in order to arrive at a knowledge of their intimate structure.

An opinion seems to be entertained by some persons, that the study of zoology and comparative anatomy should be considered rather as an amusement than as a philosophical pursuit—as something calculated to employ light minds, or occupy hours of leisure and amusement. A slight examination of the subject, however, would suffice to show that the facts it unfolds are not only interesting in themselves; but that they are instructive in the highest degree, as they tend to throw considerable light on several obscure points connected with the anatomy of the human body, by affording the means of comparing the composition, arrangement, and properties of its different organs, with the corresponding parts in the lower animals. "The varieties of organisation supply, in the investigation of each organ and its functions, the most important aids of analogy, comparison, contrast, and various combination; the nature of the process receives, at each step, fresh elucidation; and the basis of our physiological principles is rendered broader and deeper, in proportion as our survey of living beings becomes more extensive." Moreover, the study of comparative anatomy forms a useful exercise and discipline to the mind, by requiring a close attention to facts and principles, and the adoption of a clear and methodical arrangement. "This advantage of distributing and classing a vast number of ideas, which belongs in a remarkable degree to natural history, has not yet been so much insisted on as it deserves: it exercises us in that important intellectual operation which may be called method, or orderly distribution, as the exact sciences train the mind to habits of close attention and reasoning. Natural history requires the most precise method or arrangement, as geometry demands the most rigorous reasoning. When this art (if it may be so called) is thoroughly acquired, it may be applied with great advantage to other objects. All discussions that require a classification of facts, all researches that are founded on an orderly distribution of the subject, are conducted on the same principle; and young men who have turned to this science as a matter of amusement, will be surprised to find how much a familiarity with its processes will facilitate the unravelling all complicated subjects." *

3. A single instance will suffice to show the application which may be made of the researches of the comparative anatomists, in elucidating the structure and functions of one of the most complex organs of the human body, viz. that of hearing. It is obvious that the general conformation of organs must have a reference to the more or less perfect developement of the animals to which they belong, being more simple in those of the lower grades, and becoming more complex in proportion as they occupy a higher rank in the scale of animated beings; their structure, too, must bear some relation to the medium in which the animals live, and be influenced by the circumstance of their being inhabitants of the air or of water. When treating of a particular organ, for instance the ear, it may at first sight appear calculated to embarrass the subject with useless details, were we

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* Lawrence, "On the Modern History of Comparative Anatomy," p. 29. Cuvier, "Règne Animal," preface, p. 18.

to review its conformation in the different classes of animals; it may be said, that it would be far better to confine our attention to the human ear, about which alone we can feel any interest. But it should be recollected, that if a subject carry within itself any degree of complexity, there is no course more likely to lessen it than that "of proceeding from things more simple to those more compounded;" and if this principle be applied to the subject just alluded to, we shall find, that so far from rendering it more difficult, it will remove from it even the appearance of difficulty. When we examine an organ in its simplest form, we at once ascertain its essential or fundamental constituent; and if we trace it through the different orders of animals, from the lowest to the highest in the series, we can recognise each of the accessory parts which are successively superadded, and assign to them respectively the rank which they fill, and the duties they perform.

4. The simplest form of auditory apparatus is a small sac containing a fluid, and enclosing the sentient extremity of the auditory nerve; its exterior envelope is membranous, and presents an aperture which gives entrance to the nerve. In the lobster the sac is surrounded by the shell at every side, save one, where it is closed only by a membrane. Now as the sac is analogous to the vestibule in the higher animals, the openings here indicated may be said to correspond, the one with the meatus auditorius internus, the other with the fenestra ovalis. Within this first investment is placed a vascular membrane, which lines it throughout, and encloses and supports the nerve: this, however, is not expanded to the same extent as the nervous membrane of the eye; still, like the retina, it is in contact with a fluid which bears some analogy to the vitreous humour, for each is enclosed in a membrane which enables it to retain its form, and prevents it from being diffused in the cavity in which it is lodged; and both serve as media of transmission for the appropriate agents of impression. This simple apparatus is covered over by the cranial integuments; and as these exclude all contact with the medium in which the animal lives, the impressions of external objects must be conveyed to the sacculus through the surface of the head generally. The first modification which we observe in the structure of the organ is intended for the improvement of the acoustic or sentient apparatus, and consists in the addition, as it

were, to the sacculus of three semicircular canals, which are prolonged from it like so many diverticula. In some cartilaginous fishes, the organ still consists merely of the fundamental part (the sacculus or vestibule). In the scate and shark, the semicircular canals are added. In the batrachia the developement improves still farther; for in the frog there exists outside the vestibule, a cavity or chamber closed by a membrane, which circumstances assimilate it to the tympanum. In the Saurian reptiles, the first two parts of the labyrinth attain a more complete form, and a rudiment of the third is added, viz. the cochlea, which consists of the same structures as the others, and like them serves to contain a prolongation of the auditory nerve. In birds the vestibule and semicircular canals present nearly the same conformation as in the higher reptiles; the cochlea is still rudimentary; but the tympanum is large, and traversed by an ossiculum called columella; the membrana tympani may be observed at the bottom of a short auditory canal, round which the feathers and external tegument are sometimes folded, so as to represent a rudiment of a concha. In the mammalia, the auditory apparatus attains its complete developement; and as it comprises all those parts found in various degrees of perfection in the lower orders, it may be considered as divisible into four distinct compartments, each intended for a separate office.*

The essential or fundamental part (vestibule).

The accessory apparatus (semicircular canals and cochlea).

The middle chamber and its ossicula, for the transmission of sounds (tympanum).

The external apparatus for collecting and concentrating sound (external ear).

After reviewing in this way the different parts of the organ successively, and after inspecting it as a whole, we may not unaptly compare it to an edifice consisting of several apartments, each fashioned after a particular manner, and intended for a distinct purpose. The external part may be likened to the portals of the edifice, at which the visitors are collected previously to their entry, and after they have been there assembled and arranged, they are led across the ante-chamber by certain conductors stationed there for that purpose; by these the visitors are ushered into the presence-chamber, enclosed within the winding recesses of the labyrinth, and as they are successively introduced, they register on the tablet of the memory, their degrees, their titles, and their properties.

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* De Blainville, "Principes d'Anatomie Comparée," p. 450.

5. The study of human anatomy has been especially pursued by the professors of the healing art, who, on just grounds, consider it as the most secure basis on which they can rest their investigations of the functions of the body in health, and of its derangements in diseases. Were anatomists to confine their attention altogether to the human body, they would doubtless acquire a sufficiently accurate knowledge of the situation, form, connexions, and even composition of its different parts; but though an acquaintance with such details forms a necessary part of the pursuit, it is far from constituting the final object to be aimed at. The natural or healthy actions of the body must be studied as a preliminary step to the knowledge of their morbid conditions; the laws which preside over the formation and developement of living beings must be fully investigated before their functions can be rightly understood; and were we to restrict our views to the examination of any single species (even though it be the most perfect of all), our knowledge would be as inadequate, and our ideas of the laws of the economy as confined, as those of a geographer would be of the extent and resources of a kingdom, were he to limit his inquiries to a single province or department.

6. Human anatomy may be studied in two different conditions of the structures of the body, and so may be directed to two distinct objects. By the one, a knowledge of the healthy condition of parts is sought to be attained; by the other, of their morbid characters; and on this distinction is founded the division of the subject into two sections or departments, viz. *healthy* or *descriptive anatomy*, and *morbid* or *pathological.* The changes of structure induced by disease can only be ascertained by an examination of the body after death; but though a knowledge of these changes is confessedly a matter of importance, it can only be brought into practical application when they are connected with the alteration of functions, or the symptoms which had accompanied them during life. When by repeated and accurate examinations, the different lesions of each organ are fully investigated, and their appropriate symptoms so clearly ascertained that they are made to bear to one another the rela-

tion of sign and thing signified, the diagnosis of diseases may be considered as established on a basis sufficiently extended to warrant us in resting upon it our curative indications.

7. It is a mistake to suppose that the practice of medicine or surgery requires only a trifling knowledge of anatomy, or that a loose and general idea of it will suffice for the proper discharge of our professional duties. The history of surgery at once disproves such a notion by showing that the fatality attendant on operations has diminished in proportion as anatomy has been more diligently cultivated—(the best proof of an improvement in its practice that can be adduced); and the rapid advances that have of late years been made in establishing the pathology and diagnosis of diseases, more especially of those of the cerebro-spinal system, as well as of the lungs and heart, are altogether attributable to the degree of attention which has been paid to that most important department of study, pathological anatomy. The latter position is fully borne out by the great success that has attended the researches of Laënnec, Abercrombie, Lallemand, and many others; the former may readily be verified by a reference to the history of any of the more important surgical operations. The performance of lithotomy, for instance, once so formidable and so fatal, is now no longer so: it is executed with a degree of facility and success which could scarcely have been expected, if the many difficulties and dangers that beset it be taken into account. The tying of arteries for the cure of aneurisms has also been materially improved; and the improvements have gone on step by step, in proportion as a more accurate knowledge has been attained of the structure and properties of vessels, and of the anatomy of those parts of the body which are the immediate seat of surgical operations. In the mechanical or dissecting part of these processes we can also recognise a corresponding improvement, as is evident from the greater ease and celerity with which they can be now performed. Operations which at no very distant period occupied an hour, or more, are now executed in a few minutes, and with complete success.

8. It may be asked, is it a matter of much consequence whether an operation is performed quickly or slowly? Will a difference of half an hour, or of a quarter, in its duration, influence its ultimate result? Abundant evidence may be ad-

duced to show that it may, nay, that it has done so in several instances. When a patient has made up his mind to submit to an operation, he does so with a certain degree of consciousness of the risk which he encounters, and of the sufferings he is about to endure. If the operation be executed with great precision and celerity, the degree of suffering during its performance is far less than he had been prepared to expect; and when it is over, it may readily be perceived that confidence and self-congratulation at once take the place of doubt and despondency, and that a sense of security springs up in his mind, which exerts a most beneficial influence on the subsequent progress of the case. Another individual may happen to be placed under different hands, is harassed by a slow and protracted operation, begins to doubt the skill of his surgeon even whilst it is being performed, and to despair of obtaining the relief which he had so anxiously anticipated: even when the operation is completed, and he is replaced in his bed, confidence still forsakes him, for he cannot bring himself to believe that any human being could recover after sufferings so protracted, and after sustaining such a degree of derangement and injury. Those who have been long acquainted with the minutiæ of hospital practice—more especially those who have watched the cases from day to day, and noted their progress, need not be informed of the different results that attend the two classes of cases which are thus contrasted. The one they have seen cheerful and contented, making a gradual and steady progress towards improvement, whilst the others but too often sink irrecoverably, victims to constitutional irritation—to moral depression. They who have had opportunities of making such a comparison need not be told, that on the speedy and judicious performance of an operation depends alike the credit of the surgeon and the safety of the patient; and what motives more powerful can be adduced—what incentives more cogent can be urged, to impel a man of reflecting mind to apply sedulously to that pursuit on which so much depends?

9. Whilst conducting the examination of an organ, or when giving what may be termed its anatomical history, the anatomist (says Béclard)* should consider his subject as divisible into the following heads, and should treat each of them *seriatim et*

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* Anatomie Générale, p. 132.

singulatim. 1st, its form and outline—its disposition, as being symmetrical or irregular; 2nd, its situation in reference to contiguous parts; 3rd, the direction of its great diameter, which may be parallel, oblique, or perpendicular, to the axis of the body; 4th, its size; 5th, its physical properties, viz. its degree of density, cohesion, elasticity, colour, &c.; 6th, its anatomical composition and texture, or the arrangement of its integral parts; 7th, its chemical composition; 8th, the fluids or humours which it contains or secretes; 9th, the properties it manifests during life; 10th, its vital action, and the connexion of that action with others; 11th, the varieties dependent on age and sex, or individual peculiarities; 12th, the morbid changes.

10. Some of these topics may appear to belong to the departments of chemistry, physiology, or pathology, rather than to anatomy; still, "none of them should be omitted, as all are necessary to guide the researches of the anatomist."* A correct and intimate knowledge of the structure and composition of each organ is indispensably necessary to the understanding of its functions; an acquaintance with the structure and functions leads, by an easy and natural transition, to the investigation of the lesions of structure and function induced by disease—the only data on which we can establish a correct diagnosis and a rational plan of treatment.

11. The skeleton may be considered as the fundamental part of the living fabric, inasmuch as it gives form and solidity to the whole, and constitutes the substratum, to which the other parts are, as it were, applied. The skeleton is made up of several **Bones.** distinct bones which differ from one another in form and size; we usually commence with the examination of these;—and as they are united together by certain means of connexion, so **Ligaments.** constructed as to admit of various degrees of motion between the parts, the consideration of the joints or articulations, and of the textures which enter into their formation, in the next place engages attention. The bones, with their ligamentous connexions, constitute together the passive instruments of locomotion; the active agents in progression, as well as in the different efforts required to be performed, being the muscles, **Muscles.** which, as the name implies, are the moving powers of the body. Each of these exerts a peculiar action, which in most instances is

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* Béclard, p. 132.

perceptible on the slightest inspection; but if any doubt arises, it can at once be removed by a consideration of the direction of its fibres, and of the bearing of the points between which they are stretched. Muscles, however, seldom act singly; two or more usually combine in the performance of each effort, by which some advantages are gained, at the same time that the symmetry of the different parts of the body is preserved. These considerations have suggested to anatomists the idea of dividing the muscles into groups, the division being established by a reference to the manner in which they are associated in their combined actions. Winslow, when reviewing the actions of the muscles of the upper extremity, arranges them under the following heads:

Their combined actions.

1. The actions of the muscles which move the bones of the shoulder on the trunk.
2. The actions of the muscles which move the os humeri on the scapula.
3. The actions of those which move the bones of the fore-arm on the humerus.
4. The actions of the muscles which move the radius on the ulna.
5. The actions of the muscles which move the carpus on the fore-arm.
6. The actions of those which move the fingers.

Bichât coincides with Winslow as to the propriety of studying the combined actions of muscles, but he has adopted a different division and arrangement, which the author has deemed it advisable to follow, as being more simple and easy of comprehension. To the practice of surgery, an accurate knowledge of the actions of muscles is indispensably necessary. It forms the basis of all our remedial means in the reduction of dislocations; in the treatment of fractures, it determines the proper position of parts under various circumstances of accident or injury; and though, within the wide range of the anatomist's study, many subjects present themselves well calculated to awake attention—to excite an interest, there are none more likely to do so than the varied phenomena of muscular action.

12. The muscles, the bones, and all the other constituents

of the body, require support; they must be supplied from some source with the materials of nutrition and growth as well as of reparation, should they become the subjects of accidental injury. These various purposes are fulfilled by the arteries, which convey the necessary supplies; these in the next place claim attention, and require a particular examination, in order to determine with precision their course, direction, and mode of distribution. As the blood conveyed by these tubes is not altogether expended in the functions they are intended to perform, the residue, altered considerably in its properties, passes into a new set of vessels,—the veins, by which it is conveyed back to the heart preparatory to its circulation in the lungs, in which it is aërated. Now, the remote or peripheral extremities of the veins are continuous with the ultimate or capillary terminations of the arteries, the trunk being implanted into the heart; and, as they serve to complete the circle, their distribution is examined after that of the arteries, taking it, however, in the opposite direction, viz. from the branches to the trunks.

Arteries.

Veins.

13. However intimate the connexion between these different structures may be, they are linked together even still more closely by another, which may be considered as superinduced upon them, for the purpose of associating into one harmonised mass all the parts of the body, and of establishing between them a reciprocal dependence and relation. These duties are in a manner delegated to the nervous system, whose ultimate fibrillæ are ramified through all the other textures, whilst their central terminations are blended with the cerebro-spinal mass. The examination of the nerves follows naturally that of the parts to which they communicate the powers of sensation and motion, and of whose nutritive functions they may be said to be the regulators; and this would complete the consideration of the deep-seated parts, if the materials of which the body is composed were allowed to remain fixed and unchanged in the situations in which they are at first deposited. But this is not the case. The component particles of all living structures undergo a slow, but constant change; after a temporary sojourn, some parts are taken up and carried back again into the circulating mass, to make way for others which are deposited in their place. A peculiar set of vessels, the absorbents, effect these purposes, and

Nerves.

Absorbents.

are thus made subsidiary to the process of nutrition and growth. Finally, the integuments which enclose these different parts demand a greater or less degree of attention under different circumstances.

When the anatomical description of a particular part of the body is thus completed, when the structures which enter into its composition are successively examined in detail, observing at the same time a strict regard to their mutual relations and bearings, —when, in a word, the student has seen the part built up, as it were, before him, by a process resembling, as nearly as may be, a synthesis, he is naturally prompted to inquire what are the steps by which it may again be resolved into its elements, in order that he may study it for himself; or, in other words, how should he conduct its analysis or dissection? No part of the process should be treated as a matter of indifference. Every one may be turned to account if it be conducted with method. Even the first incision made through the skin may be so directed as to impress on the mind some useful practical facts. In order to illustrate the position last laid down, let us for a moment take as an instance the lower extremity, which has been kept in view whilst making the preceding remarks, and bearing in mind the leading facts which its examination has disclosed, we recollect the course taken by its main artery, the femoral. Now if the knee be somewhat bent, and the limb turned outwards, the direction of that vessel is at once marked out by a line extended to the lower margin of the patella, from a point midway between the anterior superior spinous process of the ilium and the symphysis of the pubes. This position, however, applies only so far as the vessel retains the name femoral, which is for two-thirds of the length of the thigh; for at the junction of the middle with the lower third the vessel changes its name, at the same time that it alters its relation to the bone, and is denominated popliteal. In the upper third of this course the vessel is uncovered by muscle, and is therefore the part most eligible for its compression, or the application of a ligature, whilst in the middle third it is deeply seated, and less favourably circumstanced. Now all these facts, with which every surgeon should be accurately acquainted, may be expressed, if such a phrase be allowable, by the incisions which the dissector is instructed to make, with this additional advantage, that they are the most conve-

Dissection.

nient that can be adopted for prosecuting the different steps of his examination, at the same time that they serve to leave a lasting impression on the mind; for, to use the words of Locke, " constantly repeated ideas cannot be lost."

14. In concluding these introductory remarks, it may not be amiss to point out the best systematic treatises from which information may be obtained on the subject of Anatomy, general as well as descriptive: further on, in different parts of the work, references shall also be given to such detached essays and monographs as it may be advisable for the student to consult.

BÉCLARD, *Elémens d'Anatomie Générale.* Paris, 1823; or, the English edition of this work, translated by Dr. KNOX. Edinburgh.

BICHÂT, *Anatomie Générale, avec des Additions* par BÉCLARD. Paris, 1821.

CRAIGIE, *Elements of General and Pathological Anatomy.* Edinburgh.

DE BLAINVILLE, *Cours de Physiologie Générale et Comparée.* Paris.

GRAINGER, (R. D.) *Elements of General Anatomy.* London, 1829.

The treatises of descriptive anatomy are:

BELL (JOHN and CHARLES), *Anatomy and Physiology of the Human Body,* 3 vols. London, 1826.

BICHÂT, *Traité d'Anatomie Descriptive,* 5 tom. Paris, 1802.

BOYER, *Traité Complet d'Anatomie,* 4 tom. Paris, 1815.

CLOQUET (HIPPOLITE), *Traité d'Anatomie Descriptive,* 2 tom. Paris, 1812; or, the Translation by Dr. KNOX.

CLOQUET (JULES), *Anatomie de l'Homme,* fol. avec figures lithographiées. Paris, 1824.

CRUVEILHIER, *Cours d'études Anatomiques.* Paris, 1830.

FYFE, *Compendium of Anatomy.* Edinburgh, 1826.

HALLER, *Opera Omnia.*

MONRO, *System of Anatomy,* 3 vols. Edinburgh, 1792.

PORTAL, *Cours d'Anatomie Médicale,* 5 tom. Paris, 1823.

SOEMMERING, *De Corporis Humani Fabricâ,* 5 vols.

WINSLOW, *Anatomical Exposition of the Structure of the Human Body,* 2 vols. 8vo. translated by G. DOUGLAS, M.D. Edinburgh, 1763.

ELEMENTS OF ANATOMY.

CHAPTER I.

15. The human body, considered as the subject of anatomical investigation, may be viewed as a whole made up of several parts, each ministering to distinct purposes, and all more or less necessary to the life and well-being of the individual. As effects cannot follow without causes, or actions be performed without instruments, so, in a fabric at once so complex and delicate as that of Man, many agents or organs must be employed to execute the various functions which are required for the support of the individual and the continuance of the species. These the anatomist studies, either singly or arranged in groups, according to their functions; or he resolves them into their elements, to ascertain their composition and structure. Even on a superficial inspection, an obvious division of the body at once presents itself, viz. into head, trunk, and extremities. The trunk, composed of two compartments, or cavities, encloses several of the more important organs; the inferior and larger cavity, the abdomen, contains the organs of digestion, those engaged in the secretion and excretion of urine, and part of the generative system; whilst in the thorax, or superior one, are placed those of respiration and circulation. The head gives lodgement to the organs of the senses, at the same time that its cavity, by means of its communication with the vertebral canal, encloses the central organs of innervation, viz. the brain and the spinal cord.

16. The trunk and head, in their composition, are symmetrical, being made up of two lateral halves, united along the middle line by a suture, or raphé, the traces of which are more or less perceptible in different parts; and this symmetry is closely maintained in the extremities, or agents of locomotion, which are connected, the one with the upper, the other with the lower part of the body. The external line of junction corre-

sponds with others observable in the interior, and which are the necessary results of the mode in which the body and its different organs are in the first place developed. Thus, the falx cerebri descends from the middle of the arch of the skull, taking the direction of an osseous ridge running along the frontal and occipital bones. Beneath this is the corpus callosum, forming a connecting medium between the cerebral hemispheres, and from which projects the septum lucidum, which bears to the internal cavities of the brain the same relation that the falx does to that of the cranium. The division of the nasal cavity is marked out by the septum narium; that of the mouth by the fræna of the tongue and lips, as well as by the uvula. The division in the thorax is indicated by the mediastinum, and in the heart, by the septum interposed between its cavities. In the abdomen, the only traces of its original division that exist in the adult are the falciform processes, extending from the umbilicus, the one upwards, with the remains of the umbilical vein, the other downwards, with that of the urachus; but in the penis and clitoris, the line is distinctly marked by the septum of the corpora cavernosa, and in the scrotum and perinæum by the raphé.

17. It has been hitherto supposed, that in the original developement and growth of organised bodies, the increase proceeded from the centre towards the circumference. Crystals of different salts, and other masses of unorganised matter, commence with a central nucleus, and increase by depositions upon its outer surface, their form being necessarily determined by the mode in which the deposit takes place. But in organised bodies, the outward form is sketched concurrently with the production of the inner parts, and is completed before many of them have made much progress in their developement. Their form, therefore, is not influenced by the operation of attraction, nor is the aggregation of their particles determined by its laws; for their growth proceeds from the circumference to the centre, which is exactly the reverse of what obtains in bodies acted on exclusively by mere physical agencies. Hence, in outward form, as well as in internal structure, they present the most striking contrasts with those masses of matter which belong to the mineral kingdom. This will be rendered manifest by even a cursory examination.

A mineral production, for instance a crystal, consists of particles of the same kind of matter, united by cohesive attraction. Its composition and specific gravity are fixed; and its size can be increased only by deposits laid on its external surface. Its form depends altogether on the arrangement of its components; hence it is occasionally found to be altered by the influence of various circumstances. A crystal presents several sides, bounded by right lines, meeting so as to form angles of various sizes; and by a little care it may be mechanically divided into layers, parallel with one another, and with some of the lines which bound its surface. Now as the formation of crystals is altogether owing to the deposition of particles of matter arranged according to the laws which regulate their aggregation, it must be obvious that when a crystallised body is once formed, it is quite impossible that any additional particles of the same sort can insinuate themselves between those of the mass previously existing. In order that they should do so, they must be acted on by a force greater than that connecting the particles of the crystal, which cannot be the case, as the power that acts on all is one and the same, viz. attraction. But, if a substance possessing a stronger attraction for one of the constituents of the crystal than they have for one another be made to act upon them, they are separated and dissolved, and the crystalline form is lost. We may, then, consider them as homogeneous bodies in the strictest sense of the word, the composition and specific gravity of their constituent parts being constant and determinate.

When we pass to the examination of organised bodies, we find, even in their external forms, essential differences between them and minerals. The surfaces of vegetables or animals are not bounded by straight lines; we never find in them the polyhedral form. Vegetables present externally a simple curve; animals, at least the higher ones, generally a double curve. Organised bodies cannot be separated into layers, in the same way that minerals can; for, though they present a lamellated arrangement, still the lamellæ cannot be detached or separated without being torn, or probably without causing the death of the body to which they belong. Yet water and some other fluids may be introduced into the meshes of their reticulated texture, without producing any alteration in their form, or inducing any other change except an increase in weight and size. From this it appears that the parts of organised structures are held together by a force not only superior to that of attraction, but altogether different from it.

The composition of organised bodies is not homogeneous throughout their entire extent, like that of minerals: on the contrary, it differs very considerably in different parts. Thus, phosphate of lime, the chief constituent of bone, could never be mistaken for fibrine, which is the basis of the muscular structure; and even when the integrant particles are identical, their arrangement and mode of distribution may vary considerably. Thus the long and hard bones differ very much in texture from those that are soft and spongy: the muscles of animal life can be easily distinguished from those of organic life. If these obvious facts be considered attentively, we must at once see that such marked differences could not exist if the integrant particles of animal structures were governed merely by the laws of attraction.

Unorganised bodies, such as crystals, commence with a central nucleus, and are enlarged by the deposition of layers on its surfaces. Hence, as the increase proceeds from the centre to the circumference, it may be termed concentric. Organised bodies, I should say those of the animal kingdom, grow and increase by a process the reverse of this. The developement of each part taken singly, and of the whole body taken in its aggregate, begins at the circumference, and thence proceeds towards the centre, so that the outline of each part and of the whole is first sketched, and then their completion is effected by successive depositions, taking place from circumference to centre; hence the process of growth is really eccentric, or the very reverse of what would happen were their components aggregated by attraction. This result is the fruit of modern research;* it has been deduced from an extended and cautious inquiry, and appears to be established by an adequate induction. Thus in the early periods of fœtal existence, as soon as the different textures are distinguishable, each organ and part of the body is in the first instance double, its parts being placed laterally with regard to one another; but, as the process of nutrition goes on, they gradually approach and unite, so as to form organs usually termed single, from the circumstance of their having been examined only after their growth has been completed. The process of ossification, for instance, proceeds from the circumference towards the centre. Thus, in the cranial bones, the lateral parts are formed first, and their extension proceeds from the sides, beginning at the prominent points of the parietal and frontal bones, and thence extending to the central line. Each vertebra of the spinal column, and therefore the whole pillar itself, even including the sacrum, is open along its entire length, and appears as if composed of two parts, which finally become soldered together along the median line. The principle of eccentric developement obtains in the muscular system also, the lateral parts commencing earlier than those at the middle line of the body. On the head, the temporal, the masseter, and pterygoïd muscles are the first that can be recognised; the zygomatici, the buccinator, and orbiculares come next in order; and lastly, those of the nose. On the thorax, the serrati and intercostals precede the muscles situated in the costo-spinal fossæ, as well as those attached to the sternum; and in the abdominal region, the oblique are formed in the first instance,—the recti and pyramidales, situated along the middle line, subsequently.

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* Serres, "Anatomie Comparée du Cerveau."

The nervous system, in its developement, obeys the same law: the nerves on the sides of the head, trunk, and pelvis are formed independently of the brain and spinal marrow, and their cords and filaments may be distinctly traced, so that the nerves may be said to begin where they have been hitherto thought to terminate, and *vice versâ*. The spinal cord, when just distinguishable, consists of two lamellæ, or bands, separated by a slight interval; these soon unite, at first in front, so as to form a groove, and subsequently at the opposite point, so as to constitute a cylindrical tube, which is gradually filled up by a series of lamellæ deposited one within the other, until it is converted into a solid mass of a cylindrical form. The lateral masses of the brain when first deposited are quite distinct from one another; but as the process of growth extends towards the median line, the corpus callosum and the other commissures are produced, which establish a connexion between them; and when the union is completed, its line of direction is indicated by the seam (raphé), perceptible along the upper surface of the corpus callosum, and which is found to extend quite through its substance.

18. The human body is made up of fluids and solids, each resolvable into a number of proximate constituents, and these again into ultimate elements. The solids disposed in areolæ and meshes, or formed into tubes, are permeated throughout their entire extent by the fluids, and so they bear to one another the relation of containing and contained parts. The fluids, or humours, may be divided into three sorts:

1. The blood, or central mass, which constantly flows, as it were, in a circle, alternately received into the heart, and propelled from it into all parts of the body.
2. The secreted fluids, which are separated from the blood by the different secerning organs, and are intended either for special purposes in the economy, or to be eliminated from it, viz. saliva, mucus, bile, urine, &c.
3. The fluids brought into the central mass from without;—these are the product of digestion and absorption; they are called chyle, and lymph, and are intended to supply the losses sustained by the processes of nutrition and secretion.

So long as life lasts, these fluids are subjected to a constant internal motion, in which we can trace evidences of an uninterrupted separation of old particles, and a correspondent admission of new ones. The form of the body remains the same, though its component parts are subject to perpetual mutation; and over this ceaseless cycle of change presides that power which altogether suspends the ordinary play of affinities in the first moments of fœtal existence,—modifies and controls them during the succeeding stages of life, and allows them to come into action only when it is withdrawn at death.

19. As these changes necessarily imply that the fluid parts are constantly being converted into solid structures, to maintain their growth and nutrition; and again, as the particles which had for some time formed part of the solids are taken up by the absorbent vessels, and carried back into the current of the circulation, to make way for the new matter about to be deposited in their stead; it follows, that the ultimate constituents of the solids and fluids are identical, else this ceaseless conversion of the one into the other could not take place; the only difference between them being in their mode of composition or aggregation. Thus, the following simple substances are found to exist (not se-

parately, but variously combined,) in animal compounds, viz. carbon, azote, hydrogen, and oxygen, which are the chief ingredients. To these are added some others, but in small proportions, such as phosphorus, sulphur, and iron. Various saline substances, with earthy and alkaline bases, also exist in different proportions: some, for instance, phosphate of lime, being found in considerable quantity; whilst others, such as the muriates of soda and potass, are sparingly diffused through some of the animal fluids. The soft parts are made up of azote, carbon, hydrogen, and oxygen; the hard parts, of lime and phosphorus. The proximate animal compounds formed from these are not very numerous: the following enumeration includes all that are sufficiently well characterised and are of general occurrence: gelatine, albumen, fibrine, mucus, picromel, urea, osmazome, resin, sugar, oils, acids. The identity of the ultimate constituents of these substances will at once appear from the following tabular view, which it is unnecessary to extend beyond the first three.

	Carbon.	Hydrogen.	Oxygen.	Azote.
Gelatine consists of .	47·881	7·914	27·207	16·998
Albumen	52·883	7·540	23·872	15·705
Fibrine	53·36	7·021	19·685	19·934

Gelatine, or animal jelly, is an abundant ingredient in several of the solid parts of the body, as is evident from the fact that, by boiling, it can be extracted from skin, membrane, ligament, cartilage, and bone. The solution, on cooling, forms a tremulous mass; and if the aqueous part be dissipated by heat, the remainder becomes brittle, and breaks with a vitreous fracture: this is named animal glue. Gelatine is soluble in pure liquid alkalies, and is not precipitated from them by acids: this latter property distinguishes it from albumen, fibrine, and other animal products, and points out the method of separating it from them: its most active precipitant is tannin, with which it forms an insoluble compound.

Albumen, next to gelatine, is the most abundant constituent of animal substances. It is found in a fluid state in the blood, and in several secreted fluids, such as synovia, &c.; it forms a principal basis of some solids, of cellular membrane, skin, and glands. Its appearance is that of a viscid transparent fluid, without taste or smell, which may be coagulated by the action of heat and of alcohol. The purest form in which we find it is in the white of eggs.

Fibrine forms the basis of the muscular structure, and by ablution with water may be obtained free from all the more soluble parts, except some albumen, which adheres to it. It is insoluble in water or in acids, but is dissolved by the caustic fixed alkalies. Fibrine, when pure, is destitute of taste or smell, of a pale colour, elastic, and divisible into filaments. It is obtained in considerable quantity from the crassamentum of blood, and may be recognised also in chyle.

Mucus is the viscid fluid which lubricates the mouth, nares, œsophagus, alimentary canal, and all the tubes and ducts which convey excrementitious fluids, or which open into the primæ viæ. It exists rather as an adjunct than an ingredient in some healthy secretions, such as saliva, bile, and urine, and is found in some accidental fluids, particularly in that effused in dropsies. Mucus does not exhibit either an acid or alkaline reaction. When exposed to the air, it dries, and presents the appearance of a thin pellicle. Heat does not coagulate it, by which circumstance it is distinguishable from albumen; it is not precipitated by tannin, but is thrown down by acetate of lead. It consists of water, holding in solution soda, muriate of soda and of potash, and an animal matter, which by some is called *mucine*, and considered a distinct principle.

For the description and distinguishing characters of the remaining animal compounds, such as urea, osmazome, picromel, acids, and adipose matter, the reader is referred to some of the elementary works on chemistry or physiology, as they more properly belong to these departments.

The quantity of the fluids exceeds considerably that of the solid parts of the body; but it is difficult to ascertain exactly their relative proportion, as it varies according to age, sex, and constitution. Chaussier obtained what may be considered as a fair approximation, by subjecting a body, previously weighed, to destructive distillation,—the result of which was, that the fluids were found to be to the solids as 9 to 1.

20. The proximate constituents of the solid parts of the body, as obtained by what may be termed anatomical analysis, have been variously arranged by different anatomists. Haller contended for the existence of three elementary tissues, each com-

posed of fibres, distinguishable from those of the others by certain essential and characteristic properties, viz. cellular tissue, muscular fibre, and nervous substance. The two latter cannot be considered as elements in the strict acceptation of the term; for, when examined with adequate attention, they are found to consist of two constituents—an animal matter composed of cellular tissue, the areolæ of which are filled with fibrine constituting muscle, or neurine forming nervous substance. Cellular tissue, according to its mode of aggregation, forms fibres or lamellæ, which are so disposed as to constitute cells or areolæ. This element, modified in various ways, may be said to form of itself, and directly, the greater number of the structures of the body; and when within its texture are deposited fibrine or neurine, muscular fibre or nervous fibre are the results; but the circumstances which determine the production of the one or the other cannot as yet be assigned.*

Adopting this division of the anatomical elements, we may, with Béclard† and De Blainville,‡ arrange the different textures of the body in the following order:

1. Cellular Tissue, the great pervading element forming the common basis of all the rest, and as such named by De Blainville "tissu générateur." This, variously modified, constitutes *adipose* and *medullary substance, fibrous membrane, tendon* and *ligament, serous* and *synovial membranes,* as well as the *tegumentary membranes.* It forms the animal basis of *bone,* the *coats* of ducts and vessels, and, according to some, even the middle coat of arteries.
2. Muscular Tissue.
3. Nervous Tissue.

CELLULAR TISSUE.

In plate 1, fig. 1, that structure is represented to which the name cellular tissue or texture is given. A piece of some size having been selected, it was inflated and partially dried; after which, a small portion, free from adipose matter, was detached and placed before the draftsman. Numerous very thin plates

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* Edwards, "Mémoire sur la Structure Elémentaire des Principaux Tissus Organiques de l'Homme." Paris, 1823.

† Anatomie Générale, p. 99. ‡ Principes d'Anatomie Comparée, p. 8.

(*a*) will be observed intersecting or impinging on one another, so as to enclose cells of various forms and sizes. Some of these have been laid open (*b*), others still remain closed and distended with air. A single plate, however minute it may be, can, when detached, be torn into fine filaments; hence, according to the way in which we view this as an anatomical constituent, we may say that it is laminated, thready, or filamentous: but if we look to the fact that these are so disposed as to enclose spaces, we may call it areolar or cellular. Hence arises the variety of synonyms applied to it; viz. cellular substance;—cellular membrane, or structure;—cellular system;—mucous web;—areolar, laminated, reticulated, or filamentous tissue. But, however it may be named by writers, it is confessedly the first of the solids which is developed, and that which is most generally diffused. It is made up of pale, elastic, and extremely fine plates or filaments intersecting one another in different ways, so as to form areolæ, or spaces of variable size and figure, and calculated to contain such fluids as may be deposited within them.

The quantity of cellular tissue found in different parts of the body varies considerably. In some regions we trace it in the form of a thin layer lying beneath the skin, and dipping into the interstices between the muscles. It is accumulated in considerable quantity in the flexures of joints, filling up the popliteal space, the axillæ, and surrounding the vessels at the groin. In the cavity of the abdomen a large deposit is found, usually about the kidneys; and in the pelvis a loose spongy web fills up the spaces between the reflections of the serous membrane and the different viscera. It may with propriety be said, that the cellular tissue of each region is continuous with that deposited in the neighbouring parts, and therefore forms a continuous whole throughout the system. The layer which lies beneath the skin in the neck gives off processes which pass inwards between the different muscles; it is prolonged upwards on the face, and downwards on the outside of the chest: moreover, by dipping deeply at the median line behind the sternum, it becomes continuous with that which is placed in the mediastinum, from which it is prolonged beneath the serous membranes. On each side, at the root of the neck, the cellular tissue dips under the clavicles into the axillæ, and so downwards beneath the skin of the upper extremities. From the lower part of the abdomen (where it forms a dense layer) this structure reaches down upon the thighs on each side, and upon the genital organs and perinæum along the middle line; whilst that contained in the pelvis passes outwards through the interstices which transmit the vessels and muscles, and becomes blended with the deep-seated cellular deposits upon the outside of the cavity and along the lower limbs. The whole body has thus a general investment formed of the texture now under consideration; and moreover, every organ may be said to have a special coating derived from it: so that it may not unaptly be likened to a mould which represents the form of the whole as well as of each of its parts.

When we proceed to examine individual parts or textures, we find that each muscle is enclosed in a lamella, more or less dense, of cellular tissue; so also is each fibre of which the muscle is composed; each artery, vein, and nerve has a tubular coating formed of it; the serous membranes which line the cavities are connected to their walls by it; and where they are reflected over the viscera, the medium of attachment and connexion is still the same. Such is the case also with regard to the tegumentary membranes. The density and firmness of this structure varies considerably in different parts: in some it is thin, smooth, and semi-transparent; in others, loose and spongy, viz. round the kidneys and in the pelvis; whilst in the soles of the feet it is thickened like a cushion, and so elastic as to lessen the jarring impulse of progression. From this general view of the distribution of the cellular tissue, we can readily see why different parts of it have received different names; some taken from their situation,—such as "sub-cutaneous," where it lies under the skin, forming the connexion between it and subjacent parts,—"sub-serous," where it is in relation with a serous membrane, such as the pleura or peritonæum,—and "sub-mucous," where it supports a membrane of that class. In certain situations it forms layers which support or enclose parts, viz. the different fasciæ, superficial and deep-seated, in the neck, limbs, perinæum, &c. to each of which particular attention is paid in conducting dissections, and in examining the structure of different anatomical regions: in short, it may be said that the process of dissection consists in carefully removing the cellular or laminated matter, which is laid upon some parts, as the muscles, like a veil, so as to obscure or conceal them, and forms a nidus or bedding for others, such as blood-vessels and their branches.

There are three technical phrases occasionally used to express certain circumstances connected with cellular tissue. Where it encases an organ or part, such as a muscle or a gland, it is spoken of as the "investing" cellular tissue (textus cellularis strictus); where it dips into the interior and envelopes the fibres of a muscle, or the lobules of a gland, it is termed "penetrating" (textus cellularis stipatus). Proceeding more deeply into the intimate texture of parts, we find it forming the basis which supports their proximate elements or constituents: here it is called organic or parenchymal (textus cellularis organicus vel parenchymalis). Thus we find that (disposed in minute elongated cellules like tubes) it supports and encloses the calcareous matter of bone, plate 1, fig. 3, f; the fibrine, which forms the proximate element of muscle, fig. 26; the neurine, of nerve, fig. 30; and in the interior of the secreting and other organs it supports the ultimate ramification of their ducts, vessels, and nerves, filling up the interstices between them, and binding all together: a reference to the lobules of the liver will exemplify this, fig. 24; the biliary duct at its ultimate ramification is here shown; if the arterial, venous, and nervous branches be conceived to be laid upon these, they must necessarily leave interstices between their surfaces, as all are cylindrical in form: a fine cellular tissue fills up these, and at the same time binds all the constituents together.

Not a little difference of opinion has prevailed amongst writers as to the intimate anatomical composition of this substance. It was supposed by Mascagni to consist of white vessels, which so far accorded with the views of Boerhaave, who contended that all the textures of the body were made up of packets of tubes, diminishing in size as they increased in number by successive divisions. Ruysch, too, from the minuteness of his injections, inferred it to be vascular. Bordeu, who wrote an essay expressly upon it, maintained it to be a homogeneous, viscid, and tenacious substance *(tissu muqueux)*, without assignable form, and scarcely deserving the name of a solid. Meckel adopts this opinion;—and it may be fairly tenable with regard to several of the lower animals, and to the fœtus at an early period; for in these cases, neither its fibres, laminæ, nor cells are easily perceptible, but they may be rendered apparent by gently drawing apart any two structures between which cellular tissue is deposited. Meckel, however, seeks to explain this away by attributing the effect to the admission of air into its interior, which channels its naturally viscous and homogeneous substance into cells, or stretches it into filaments. Most persons now agree in considering it to be made up of cylindrical filaments, crossing in various ways, so as to form a net-work. The filaments, in most parts, by being aggregated together, constitute lamellæ, enclosing spaces or cells, which present an infinite variety of forms and of size, but which still freely communicate, as is proved by the gravitation of effused fluid in anasarca, and by the diffusion of air all over the body in some cases of emphysema.

The use of the microscope does not furnish us with any additional facts besides those just stated. Some imagine that they recognise in its filaments minute globules disposed in linear series. This, however, appears to be an optical illusion.

As to its physical properties, cellular tissue is very flexible, and therefore does not in any way restrain the movements of parts. It admits of considerable extension; and when the distending cause is removed, whether it be a tumour or an effused fluid, it will gradually return to its original condition. This is obviously a result of elasticity. Its degree of cohesion varies considerably in different parts.

When considering its vital properties, we ask, Is it sensitive? Is it contractile? Formerly, not a few were disposed to answer both questions in the affirmative. It was sensitive according to the views of those who classed all membranous and tendinous structures amongst the most sensitive parts of the system. But any sensibility manifested during experiments on living animals is obviously owing to injuries done to the nerves which it lodges or transmits to contiguous parts. It does, however, become highly sensitive when inflamed. Contractility it does not possess, at least in that sense in which muscles are contractile: any power of retraction which it manifests appears to be an effect of elasticity.

The quantity of fluid contained in the vacuities of cellular tissue varies considerably from time to time: it is therefore the seat of exhalation and absorption. Are there, it will be asked, two sets of vessels, the one to pour out, the other to take up this fluid? The existence of exhalent and absorbent vessels on the surface of membranes appears to be altogether an assumption, readily taken for granted, and assented to, merely because persons could not conceive by what other means fluids could be effused and then absorbed from the interior of cavities. The existence of such vessels (exhalents terminating upon, and absorbents commencing from free surfaces,) has never been demonstrated: it is therefore unphilosophic to assume it. Moreover, the phenomena can now be easily accounted for by the known properties of membranes. The property of imbibition, as demonstrated by Majendie and Fodera, or that of endosmosis and exosmosis, to use the terms devised by Dutrochet, supplies us with an adequate rationale of the phenomena in question. This shall be stated in the section on serous membranes.

When we inquire concerning the chemical composition of this substance, we find that Fourcroy considered it to be made up of gelatine. It is well known that gelatine can be extracted, by boiling, from membrane, tendon, ligament, and all those structures whose base is cellular tissue; also, that it exists in greater abundance in young than in old animals. Mr. Hatchet's experiments lead to the conclusion that albumen forms the basis of this substance, with a variable proportion of gelatine: to these may also be added animal mucus. The ultimate constituents, according to Chevreul, are as follows: oxygen 23·872, hydrogen 7·540, carbon 52·883; azote 18·750. Probably, its power of resisting putrefaction is owing to the small proportion of azote which it contains.

ADIPOSE TISSUE.

The synonyms of adipose tissue are tela adiposa, tissu adipeux, tissu graisseux. Many persons consider adeps as a mere modification of cellular tissue; the only difference being in the nature of the deposit contained in the cells, which in one case is serous or watery, in the other oily. Not a few contend for the existence of vesicles which line the cells of the ordinary cellular tissue wherever fat is deposited, and act as secreting agents in producing it. Distinct adipose vesicles are not very easily demonstrated; their existence is inferred in order to account for certain phenomena. For instance, it is a matter of common observation, that fat, though fluid in some animals, as in the spermaceti whale, and semifluid in many others, yet does not gravitate; and if a few particles of it be taken from an animal and placed in water, it does not diffuse itself so as to be seen on the surface of the fluid in the form of globules until heat is applied, which bursts the vesicles. Neither do fatty accumulations pit on pressure as dropsical effusions do. All this, it is said, leads to the inference that the deposit is enclosed in proper vesicles, between which no communication exists. Now, in the early stages of fœtal life, adipose matter appears in the form of granules beneath the skin, and in a few internal parts, as about the rectum. In youth its chief seat is beneath the skin; in old age, the limbs become thin, and the adeps accumulates in the omenta, about the abdominal viscera, and even round the heart. Are we then to conclude, that vesicles are produced preparatory to its reception, and that they appear and disappear in particular portions of the ordinary cellular tissue according as the secerning vessels discontinue or assume that action which is necessary to the deposit of fat? De Blainville* examines the matter in this way: He takes a fragment of mutton suet, or of marrow; at a low temperature it is granular, or even crystalline; a few of the granules are carefully detached, and placed on the port-object of a microscope previously warmed:—He observed them to melt without leaving a trace of any special envelope or vesicle. In fig. 2, a small piece of adipose substance is shown: the separate masses, c, appear like membranous cells, in every respect similar to those of cellular tissue; the question then arises, are there any distinct vesicles within these? Raspail † states that he can satisfactorily demonstrate the existence of such vesicles enclosing the granules of adeps, and connected with the cellular tissue which surrounds them by a hilus analogous to that which exists in more complex structures.

If a small piece of mutton suet be slowly torn into fragments over a gauze filter placed upon a glass vessel, and water be allowed to trickle upon it, granules of various sizes will be carried down. All extraneous matters will be arrested on the filter, the adipose grains alone passing through: these may be readily collected from the surface of the water in the glass vessel, and subjected to examination under the microscope. Their outline often presents defined facetts so as to give them a polyhedral or crystalline form; but a more attentive examination, with at the same time due attention to the regulation of the light, will show them to be rounded or slightly oblong. Their size varies in different animals, being greater in the hog than in the sheep or ox. "It may be objected," says Raspail, "that as these particles are as fluid, or nearly so, as oil, they are not really cellules, but drops of oily matter aggregated together. By puncturing one or more of them, it will be found that each is enclosed in its proper vesicle." Though De Blainville denies the existence of any envelope to the adipose granules distinct from the common cellular tissue, he still admits that each consists of a more concrete outer coating with something more fluid in the interior; but he seeks to explain this away by supposing that the two elements of adeps may even in the living state be distinct, the stearine forming the outer, and the oleine the inner part of the adipose granules. This opinion is not likely to be adopted by many.

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* Cours de Physiologie, Leçon 11.

† Chimie Organique, p. 190.

Adipose tissue may be said to consist (on examining a small mass such as is represented, fig. 2,) 1. of cellular tissue which forms the nidus, or common substratum, the cellules of which, with their membranous walls, are distinctly seen, *c*; 2. of nutrient vessels, *d*, which ramify with extreme minuteness amongst these: 3. in the interior of each cell others are enclosed of still smaller size; and so, perhaps, in the third remove, we get to what may be considered the ultimate vesicle. These included vesicles appear to be attached at one point to the cell which contains them: this Raspail likens to the hilus in more complex structures, fig. 2, *e*. The vessels at their capillary terminations secrete or exhale the adipose matter into the vesicles, and this takes place in considerable quantity in certain states of the system, or under the influence of rest and nutritious diet. In opposite circumstances,—for instance, under privations, or in ill health, or febrile action,—a rapid absorption is observed to be set up. It appears, then, to be deposited as if by an exhalent action beyond the current of the circulation, but still so as to be readily brought back when the wants of the system require it.

The mode of distribution, as well as the appearance, colour, and consistence of adipose matter, vary considerably in different situations. It extends in the form of a layer of variable thickness under the external tegument. It forms masses which fill the interstices between the parts in the orbits; also in the cheeks, in the flexures of joints, and round the kidneys. In the omentum it is deposited in branching lines or bands following the course of the blood-vessels. We find adipose deposits in the joints under the synovial membranes, particularly where they form folds, or are reflected over interstices between the inequalities of articulating surfaces. We find none immediately under the mucous membranes, nor in certain parts of the external tegument, such as the ear, nose, and eyelids, the prepuce or nymphæ. Neither does any exist in the cerebral cavity; though in the spinal canal a thin layer of soft adipose matter is found between the dura mater and the vertebral canal.

When digested in alcohol, adeps is resolved into two proximate constituents, called by Chevreul stearine (στεαρ fat) and oleine (ελαιον oil); names which express the leading characters of these principles, the former being comparatively solid, the latter fluid. Upon the relative proportions of these depend the different degrees of fluidity or of firmness in the fat of different animals, or of different parts of the same animal. Both are devoid of taste and smell; neither do they manifest acid or alkaline properties. Adeps contains no azote; carbon greatly predominates over its other constituents. In round numbers we may say that it consists of oxygen 9 per cent. hydrogen 11, and carbon 78.

Medulla, or marrow of bone.—The cavities and cells of bones are filled with a substance called marrow, which is most distinct in the canals of long bones, as in the femur and humerus. Its constituents are the same as those of common adeps, their relative proportions varying a little. It consists, according to Berzelius, of pure adipose matter, 96; extract, albumen, jelly, &c. 3; membrane, 1. It is more fluid and of a yellower tinge than fat. The medulla is enclosed within the meshes of a membrane, which forms a tubular lining for the canal within the bone, at the same time that, by means of lamellæ and processes projecting inwards, it forms a number of small cells containing the marrow. It was usual, at one time, to say that this deposit served the purpose of diminishing the fragility of bones, and rendering them more flexible, by permeating their structure. There is, however, no reason to suppose that it comes into direct contact with the earthy matter of the osseous tissue. Its obvious purpose seems to be to fill up the cavities and areolæ of bones; and as it is demonstrable that these cavities lighten the bone without diminishing its strength, oily matter, by reason of its moderate specific gravity, is the best fluid that could be selected to fill them. Surgeons have often discussed the question, Is the marrow sensible? Animals, made the subject of experiment, will manifest sensibility or not, according to the point at which the marrow is exposed. If a long bone be sawed across beyond the foramen which transmits the vessels and nerves into the canal, sensibility will be exhibited if the marrow be irritated, for it is still in direct connexion with the central organ of the nervous system; but if the section be made at the proximal side of the foramen, this connexion is cut off, and the medulla will be no longer sensitive.

The existence of the medullary membrane in the interior of long bones may be demonstrated by sawing the shaft across, and exposing it to heat, which will crisp the membrane, and cause its separation in the form of a thin delicate lamella. Towards the extremities of the bones the medullary membrane appears to be continuous, with a similar lining of the different cells; but their extreme tenuity renders it difficult to demonstrate the fact.

FIBROUS TISSUE.

Some of the ancient anatomists included all the white structures under one denomination—nerve (νευρον). Hence, even to this day, a swelling upon a nerve and a tendon is called by the same name, viz. ganglion; though the one is a natural condition, and the other a diseased state. But the nerves, properly so called, were clearly distinguished from the ligamentous and tendinous structures by Praxagoras; and the distinction was followed out by Galen, and maintained by all anatomists since his time.

The fibrous tissue is indiscriminately termed ligamentous,—aponeurotic,—albugineous,—tendinous. It is also sometimes called the white fibrous texture, to distinguish it from the red or muscular. From the number of synonyms here indicated, it must be evident, not only that the structures collected under this head are variously named by different writers, but also that several apparently distinct structures are included within it. However different the objects may be in external form, appearance, or use, they still agree in being made up of white and shining fibres, either disposed in planes, collected into bundles, or formed into tubes. Their colour is not uniform, being in some parts not unlike that of mother-of-pearl, in others white, with a slight yellow tinge. Being a modification of cellular tissue, which is proved by long-continued maceration in water, or by the action of dilute acids, its ultimate constituents are necessarily the same. Firmness and power of resistance are the best-marked properties of the fibrous tissue; hence the term "tissu scléreux," (σκληϱος, hard, firm). It does not contract when irritated, and retracts but very little when divided. In its natural state it manifests no animal sensibility, but becomes highly sensitive when inflamed or greatly stretched, as happens in dislocations. It strongly resists any sudden distending force, (intense pain speedily following from the pressure it suffers,) but gives way to a slow, gradual distension, and again returns to its original condition when the cause is removed. This is observed in cases of effusions into joints or beneath investing membranes. The vessels of supply are very few; the pericardium and the dura mater receive a greater number than any other white fibrous structures; nerves and lymphatics have been found to terminate in scarcely any of them.

Bichât, when examining the fibrous tissues, adopted from some of the ancient anatomists the notion that they were not only connected together, but had a common centre from which they are all derived, just as the different parts of the vascular and nervous systems are said to be derived from the heart and the brain. This centre he located in the periosteum, which must be allowed to be a sufficiently extended one. There are no adequate reasons for attempting thus to centralise the different fibrous structures; for little, if any, sympathy or functional connexion exists between them: they do not even form a continuous whole, some of them being totally detached and insulated from the rest.

The arrangement of the fibres presents numerous varieties, for the organs they make up are calculated to serve many purposes, and therefore present several modifications. In reference to their form, however, all may be classed under two heads, viz. first, those which are broad, thin, and expanded into membranes; second, those whose length much exceeds their breadth, in consequence of the fibres being aggregated into bundles or fasciculi.

Fibrous membranes.—These consist of a number of fibres running parallel in their whole length, and at the same time intersected and crossed by others in such a way as to form a close firm web. In some instances they expand so as to embrace a whole limb, like a band or sheath, and therefore receive the name *fascia:* hence have arisen the terms fascia lata of the thigh, fascia of the leg, fascia of the arm and fore-arm, cervical fascia, &c. Fibrous membranes also form special investments for many important organs, viz. the dura mater which surrounds the brain and spinal cord, the sclerotic coat of the eye, the external layer of the pericardium, the tunica albuginea of the testis. To these should also be added the capsular ligaments of joints, and those broad membranes which bind down or support parts, viz. the temporal fascia, the perinæal and obturator fasciæ.

Aponeuroses, in their general conformation, as well as in structure, resemble fibrous membranes; they are merely somewhat thicker, and their fibres more strongly marked. The term aponeurosis is now applied to an expanded fibrous lamella, which forms a continuation of a broad flat muscle, and serves as the means of attachment for its fibres; for instance, the aponeuroses of the oblique and transverse muscles of the abdomen, and of the latissimus dorsi. The crossing and interweaving of the fibres are obvious in all these examples, even on the most cursory inspection.

Periosteum (περι about, οστεον bone), as its name implies, is the immediate investment of bone, with which it maintains important relations. Plate 1, fig. 3, a small piece of the membrane *g*, which invests the bone *f*, is here represented as detached from it and thrown down; it is drawn from a preparation of the parts as they are seen suspended in a bottle. Having the same general shape as the bone with which it is in contact, it is intimately connected with the osseous structure by means of the nutrient vessels which pass through it, conveying materials of supply, and also by delicate filaments which accompany them. Its outer surface is rough and flocculent, by reason of the numerous connexions which it maintains, and the many points of attachment it affords to tendons, muscular fibres, &c. It is made up of dense, firm, pale, fibres; its thickness varies in different parts and at different periods of life, being at first very thin and with little appearance of vascularity; but as ossification proceeds it becomes thick and vascular. The periosteum invests the bones throughout their entire extent, except at their articulating extremities; but though its continuity is interrupted at the movable articulations, the membrane passes over the immovable ones, and assists in maintaining the connexion between their parts. Its uses are various, as it not only forms an investment for the osseous structure, but also serves to transmit and support their nutrient vessels; it gives attachment to tendons, ligaments, and muscles, and so forms their bond or medium of attachment to the bones; and in infancy, before ossification is complete, maintains the epiphyses in connexion with the bodies of bones. The structure and general conformation of periosteum are readily exhibited after a bone has been for some time steeped in water, when the membrane can be detached, and with it the tendons, showing that it is the medium by which they are connected with the bone.

Perichondrium.—The investing membrane of cartilage is called perichondrium (περι about, χονδρος cartilage); its structure, uses, and general properties are similar to those of periosteum, the only difference being, that it is thinner and less vascular.

Compound fibrous membrane.—Fibrous membrane is often united with lamellæ of a different tissue, so as to form a compound structure. The fibrous periosteum of the palate and gums, of the nasal fossæ, and of the different sinuses which communicate with them, is connected with the mucous membrane which lines all these cavities, and is therefore usually described as a *fibro-mucous* structure. Again, the pericardium, the dura mater, and the fibrous capsule (albuginea) of the testis, are termed *fibro-serous*, inasmuch as each of them is united with a serous membrane.

Tendon (τεινω to extend) is the most ordinary sort of fibrous adjunct to muscle, serving as the means by which it is prolonged and fixed to its points of attachment. Tendons present many varieties of form, some being narrow and cord-like, as we see in those which stretch along the wrist and ankle to reach the fingers and toes, where, by sliding over pulley-like surfaces, they take a new direction, and so modify the lines of action of their respective muscles. In other parts we find them compressed and strap-shaped in the middle, and expanded at one or both extremities. The tendo Achillis is convex on its cutaneous surface, and flat at the other, its fibres spreading out considerably where they run into those of the muscle; the tendon of the plantaris is very narrow and thin, but may be easily spread out to ten times its natural breadth; its borders will then resemble a piece of chamois leather after being stretched, and scarcely a trace of fibre will remain in its structure, so smooth and even does it become.

Fibrous sheaths (thecæ) are tubes or canals which confine tendons to their proper positions. They are well marked at the palmar aspect of the fingers and toes, where they guide the flexor tendons to their destinations; their margins are attached along the borders of the bones, and their inner side lined by synovial membranes, as a protection against the effects of friction. A similar provision occurs where the tendons curve behind the ankles to reach the foot.

Ligaments (ligamenta, λειγω to bind) form the chief means by which the numerous pieces of the osseous system are bound together, so as to constitute one whole—the skeleton. Their form and size must vary considerably in different parts, some being flat bands, some rounded cords, and others short but wide tubes, attached at both ends to bones which admit of free movement upon one another, as we see in the capsular ligaments of the hip and the shoulder. Viewing ligaments in this way, we may divide them into two groups, the funicular or cord-like, and the capsular; they are also called, from a mere consideration of their position in relation to their respective joints, anterior and posterior, internal and external, lateral. Most ligaments enter into the formation of joints, and are therefore articular; some, however, merely fill up spaces, as the inter-osseous ligaments in the fore-arm and leg; or connect parts between which no motion exists, at the same time that they diminish vacuities, of which the sacro-sciatic, and the two proper ligaments of the scapula, furnish examples. The term "false ligament," is frequently applied to certain folds of serous and synovial membranes, from their being supposed to confine the parts to which they are attached. The broad processes of peritonæum extended from the bladder and uterus to the sides of the pelvis, also the so-called ligamentum mucosum in the knee-joint, may be cited as instances: the expression is obviously ill-chosen, and should be discontinued.

Fibro-cartilage, as the name implies, is a structure intermediate between fibrous tissue and cartilage, and partakes of the qualities of both, viz. firmness and elasticity. Being calculated to serve different purposes in the economy, it presents not a few varieties both of appearance and structure. Thus, we find it in the form of broad thin plates in the pieces of the larynx and epiglottis, in the pinna of the ear, in the lateral and median cartilages of the nose, and in the tarsal cartilages of the eye-lids; for in these parts it forms their basis of support, and determines their form; whilst in the trachea it consists of narrow plates curved round the tube, forming a series of rings. In the immovable articulations, fibro-cartilage is interposed between the contiguous surfaces of bones, in layers of various forms and thickness, constituting in some instances the principal means of connecting them together, as we see at the junction of the ossa pubis, and also of the bodies of the vertebræ, in which instances the elastic property is of considerable utility. In some of the movable articulations, pieces of this structure are also placed, their form and size necessarily varying in each instance. In the knee joint,—in the articulation of the lower jaw-bone, and in that of the clavicle with the sternum, they diminish the effects of jarring motions by their elasticity; and by a certain degree of mobility, which allows them to give way as the bones move upon them, they keep up a perfect adaptation between the parts, notwithstanding the many inequalities of their surfaces. In the hip and shoulder-joints they are so disposed as to deepen the articulating cavities, and lessen the liability to dislocation.

Cartilage (cartilago, tissu cartilagineux, *χονδϱος*) is much more dense and solid than any of the preceding textures; it is highly elastic, and by its resiliency resumes its original position when any compressing force to which it may be exposed, is removed. Its colour is in general a silvery white, and not unfrequently presents that of mother-of-pearl; its density is such, that all trace of its cellular nature, or of its being a modification of cellular tissue, is lost. Mr. Hatchett considers its chemical composition to be albumen, and a small quantity of phosphate of lime. It contains a considerable quantity of water, consequently soon dries on exposure to the air, becomes yellow, semi-transparent, and loses its elasticity; it resists maceration, and the action of cold water, for a long time, but is soon acted on by acids, or by boiling water, and converted into a gelatinous pulp.

Cartilage serves as an adjunct to bone, or a substitute for it. In early infancy the different pieces of the skeleton are cartilaginous; but in the progress of growth, bone becomes deposited in their place, and gradually supplants them altogether; such cartilages are termed *temporary*. The articulating extremities of bones are covered with layers of cartilage, not merely to smoothen them, but also, by their elasticity, to lessen the effects of concussion. The thickness of these layers varies from half a line, or even less, to two lines; it will generally be found greatest along the margins of concave surfaces, and towards the centre of those which are convex. The free surface of each articular cartilage is covered by the synovial membrane of the joint, from which it is impossible to separate it; the attached surface is in equally intimate union with the bone on which it rests.

The *costal* cartilages form so many elastic prolongations of the ribs, serving not merely to complete the arch from the spine to the sternum, but also, by means of their elasticity, to restore the ribs to their original position, after having been elevated by the effort of inspiration.

Elastic fibrous tissue (tissu jaune élastique—tissu fibreux jaune,—ligamenta flava—subflava) consists of pale yellow fibres placed parallel, whether their general direction is perpendicular or oblique, no decussation or crossing being observed between them; they are easily separable from one another, as but little cellular tissue connects them. As its name implies, elasticity is the chief property of this structure wherever it occurs, being developed to such a degree as to render it well calculated to form suspensory ligaments, or to invest parts which are subject to considerable alternations of distension and contraction. Thus, in quadrupeds a strong band of elastic tissue (ligamentum nuchæ) extends from the spinous processes of the neck, and from some of those of the back to the skull, the weight of which it supports without producing that sense of fatigue which would necessarily arise were muscle the sustaining power. The corresponding structure in man is reduced to a rudimentary state, the balanced position of the head on the spinal column rendering any further provision unnecessary. The same material enters into the composition of the ligaments which connect the arches of the vertebræ (ligamenta subflava), and also, according to some, into that of the corpora cavernosa. The fibrous investment of the spleen, the ducts of salivary glands, and even the middle coat of arteries, are thought by many to be composed of elastic tissue. The consideration of the latter point must be reserved for the section on arteries.

OSSEOUS SYSTEM.

22. *General description.*—The osseous system (système osseux, ossa, ὀστεα) is peculiarly fitted, by its solidity and hardness, not only to give support to the soft parts, but also to furnish points of attachment to the muscles, by which the different movements are executed. This solid frame-work of the body is made up of a number of separate pieces, the aggregate of which has been termed "*the skeleton.*" It is a favourite opinion with some persons, that bones determine the form of parts, as well as the direction of the body. But we find, that in their developement they just keep pace with that of the soft parts, particularly of the central nervous masses. If these proceed regularly to their completion, so will the arches of the vertebræ, and the bones of the head; but if their growth be retarded or deranged, the bones will not arch inwards, and so the spinal and cranial cavities will remain open. Again, if we descend through the series of animals, the skeleton becomes gradually more simple and rudimentary, until it is reduced to its fundamental part—the spine; and even this may be composed of cartilage, with scarcely a trace of calcareous matter. A few grades lower down in the scale, we find multitudes of animals altogether destitute of a skeleton, either internal or external, so that the muscular structure alone remains as the means of locomotion. Bone is, then, the passive instrument—muscle the active agent: muscle is moreover prior in its appearance and importance in the animal series, bone being secondary in both respects. It may be asked, are we still to persist in drawing such a broad line of distinction as has been hitherto done, between the hard calcareous parts of crustacea and insects, and the osseous system of higher animals, as that the latter alone should be considered to merit the name of skeleton,

whilst the former is treated as a mere shell, or outward tegument? To put the question in a different way, is it more conformable with what we know of the economy of nature—is it more philosophic, to admit, at once and without examination, that these so-called shells or crusts are altogether new organs given to the animals they invest, (and as such, destitute of any analogy with the structures observed in higher grades of beings, and with which we are in general more familiar,) or to scrutinise these different parts attentively, and carefully note the points of similitude, if any, which may exist between them, with a view to determine whether they are not really modifications, or repetitions, of what occurs in other tribes, and so trace out (what analogy goes a great way to establish) a unity of plan throughout the animal series? The researches of Geoffroy Saint-Hilaire and others have thrown much light on this important question. The mere position of parts, whether internal or external, is a matter of little moment; a consideration of their structure, and adaptation to purpose and use, can alone determine whether any correspondence exists between them. The internal skeleton of a vertebrate animal, and the external one of the articulata, appear to be really analogous parts in the economy of these classes of animals, notwithstanding the vast distance which separates them in the scale of being; and the difference, though confessedly a considerable one, which exists between the rachis of a crustaceous animal and that of a fish, reptile, bird, or quadruped, seems to arise from the circumstance that a spinal marrow exists in the one, but not in the other, a special conformation of the osseous system being required in each case.

Situation.—The osseous structure is situated deeply, being covered by the soft parts and common integuments; at least, this is the case in the vertebrated animals.

23. The *number* of bones is differently stated by writers, the difference arising from the period of life at which the enumeration is made: in early age the number is greatest, and subsequently diminishes, when, by the process of ossification, two or more previously distinct pieces become united into one. Their *form* and *size* present a considerable degree of variety. They are usually divided into long, short, flat, and mixed.

The *long* or *cylindrical* bones belong in general to the parts intended for locomotion, and represent so many levers, to be moved by the muscles in various directions. When examined from the superior part to the inferior, viz. from the humerus or femur, to the phalanges of the fingers or toes, they are found to increase successively in number as they diminish in size—a disposition which gives to the superior division of each limb the great extent of motion it enjoys, whilst it allows to the inferior and terminal ones, a variety of rapid movements within restricted limits.

Each long bone presents a body, or middle part, and two extremities. The shaft or body is round and cylindrical in some, prismatic in others, but somewhat bent or twisted on its axis, so that the direction of its superior extremity does not exactly correspond with that of the inferior. Whatever difference of outward form may obtain, there is little or none in that of the internal canal; it is circular in the tibia as well as in the femur. This canal is not intended merely to lodge and protect the medulla; it contributes very much to increase the strength of the bone, as has been satisfactorily shown by direct experiment. If two cylinders contain the same quantity of matter, one being solid, the other hollow, the power of resistance of the latter is greater than that of the former, owing to its greater diameter. By this conformation also, bones, without being increased in weight, acquire an adequate degree of lightness, together with sufficient superficial extent to afford a more expanded surface for the attachment of muscles, which are important requisites in what may be considered as the passive organs of locomotion.

The *short* bones are usually situated in parts in which solidity and firmness are required to be combined with freedom of motion; for instance, in the carpus, tarsus, and vertebral column. Their external conformation is necessarily influenced and determined by that of the parts into whose composition they enter, and as they are intended to cooperate in certain common functions, they present a number of articulating surfaces, prominences, and depressions, suited to their mode of adaptation and mutual connexion.

The *flat* or *broad* bones for the most part serve to form the walls of cavities, or to enclose spaces. They present two surfaces, one convex, and the other concave; which conformation, by giving them an arched form, increases their power of resistance, and affords additional security to the organs they enclose. The bones of the skull and pelvis come under this denomination.

Some are so irregular in their form as not to be referrible to either of these heads. These are situated along the median line, as the occipital, the sphenoid, and ethmoid bones, and the vertebræ.

In addition to these divisions into classes, adopted by all writers, those who treat expressly of descriptive anatomy are obliged to have recourse to others. Thus, in order to facilitate the description of irregular bones, such as the ethmoid, or the sphenoid, they are considered as being divisible into a central part or body, and processes; the anatomical situation of the parts forming the ground of division. In other instances it is supplied by the mode of developement, as of the os innominatum into ilium, ischium, and os pubis. Finally, in some, the division is founded on the situation and relations of their parts, as when the frontal bone is resolved into a frontal, nasal, and orbital portions.

24. The *surfaces* of bones are marked by eminences and depressions adapted to various purposes. The eminences may be ranged under four heads. 1st, those of articulation; 2d, insertion; 3d, impression; 4th, reflection. Those for articulation vary according as they are movable or immovable, and shall be described in the next chapter. Those for insertion are variously adapted for the attachment of muscles, or for tendons and ligaments. They present numerous differences in their degree of projection, according to the sex, age, and muscular developement of each individual. Their form is equally various; some consisting of diffused asperities, others extending along the surface like rough lines, whilst others project more or less from the bone, intended not only to give insertion to muscles, but also to serve the purpose of increasing their power of action, by removing their line of direction farther from the axis of the bone.

The eminences of impression are certain prominent lines interposed between depressions on the surfaces of bones. Thus, the shallow pits on the cranial bones corresponding with the convolutions of the brain, and the depressions on the external surface, marking the insertion of muscles, are separated by prominent lines, termed eminences of impression. The expression appears not to have been well chosen; it was originally founded on the supposition that the action of contiguous organs, by depressing certain parts of the surface of the bone, served to elevate others; but it is far more comformable to what occurs in other structures, to refer to the laws of nutrition and growth, (by which different parts are mutually adapted to one another,) the inequalities here alluded to, as well as those more prominent points to which muscles are attached. The latter are usually attributed to the action of the muscles drawing them out, and as it were moulding them; but, as Bichât observes, such an opinion, founded on what occurs in soft and inorganic substances, ill accords with the known phenomena of vitality. We observe eminences for the insertion of ligaments, which project more than those which give attachment to muscles; for instance, the spinous process of the ischium: there is, moreover, no proportion between the elongation of different apophyses, and the power of the muscles attached to them, viz. between the styloid process of the temporal bone and its muscles.

The term or phrase "eminence of reflection," is not often used. It expresses a fact which we occasionally observe, viz. that tendons slide upon elevations at the ends of bones, by which their direction is changed. As an instance, we may cite the case of the peronei muscles, and the flexors, which run behind the malleolar projections of the tibia and fibula, by which these tendons take a new direction, and modify the line of traction of their respective muscles.

The prominences on the surface of bones are variously named, according to their form, degree of elevation, and the uses which they serve. When of considerable size they are called *apophyses* (processus, apophysis, *απο* from, *φυμι* to grow). These, in most instances, are appendices to the body or shaft of long bones, in infancy and in early life, when they are called *epiphyses;* but as the process of ossification proceeds to its completion, they become, as it were, soldered to the rest of the bones. The term *tuberosity* (tuber) denotes an eminence, rather broad and rough, but not much projecting; *tubercle* (tuberculum) expresses something still smaller. A process, which is thin and tapering, is called *styloid*, from its resemblance to the Roman writing instrument (stylus). A sharp thin projection is called *spine* (spina). But one which runs along like a ridge, is called a *crest* (crista). An apophysis, when rounded, is usually called a *head* (caput), and the constricted part supporting it represents its *neck* (cervix, collum). *Condyle* is a compressed apophysis, which forms part of an articulation.

25. The depressions and cavities on the external surface of bones are divisible into the articular and non-articular. The former shall be treated of in the next chapter; the latter, being very numerous, may be ranged under the following heads. 1st, those for insertion; 2d, for reception; 3d, gliding; 4th, transmission; 5th, nutrition. Those for "insertion" are well adapted for the attachment of muscle, ligament, &c. by increasing the extent of space allotted for that purpose, inasmuch as a concave surface presents a greater extent than a plane one bounded by the same line. Some of these, as the digastric and pterygoid fossæ, by the greater depth at which they allow the muscles to be inserted, increase their power, by permitting an elongation of their fibres.

The bones of the skull and face present several instances of "cavities of reception." Some correspond with the whole extent of a bone, as in the case of the parietal bone. Some occur in a particular part only, as the fossa in the nasal process of the superior maxillary bone, and os unguis for the lachrymal sac.

The depressions for "gliding" are situated about the heads of long bones, being grooves, in which tendons slide, as they pass to their destinations. The formation of these has been attributed to the influence of the mechanical pressure and friction of tendons. But such a rationale is inadmissible; for they are found in subjects paralytic from infancy, and are by no means proportioned in depth to the force of the muscular exertion which bears upon them. The different configuration of bones should rather be considered as the result of the laws of ossification which preside over the growth and developement of the osseous system, and by which its different parts are adapted to their appropriate purposes.

The cavities for "transmission" give passage to vessels and nerves; their form is various, some being mere fissures, others tubular, &c.; to this head are referrible most of the apertures at the base of the skull.

The foramina of "nutrition" transmit the vessels intended for the support of the substance of the bones and of the medulla; they are divisible into three orders. The first usually receive the name of foramina of nutrition, though in strictness it does not belong to them more than to the others, the only difference between them being, that they transmit vessels to supply the medullary membrane, whilst the others give passage to those which are distributed to the substance of the bone. The first set, considerably the largest, are situated towards the middle of the long bones, and penetrate their substance in an oblique direction. The second order of foramina are much smaller, but very numerous; they are most perceptible towards the extremities of long bones, and generally all over the surface of the short and thick ones. But the third are so minute as to be perceptible only by the aid of a glass, by which we can discern them all over the surface.

The depressions and cavities in bones differ so much in form, size, and use, that it has been deemed necessary to devise certain terms to mark these differences. A deep pit which receives the globular head of a bone, is called a *cotyloid*, or cup-shaped cavity (κοτυλη a cup), or an *acetabulum* (an ancient cup or measure), *ex. gr.* the socket which receives the head of the thigh-bone. If shallow and superficial, it is said to be *glenoid* (γληνη a shallow pit); the articular surface of the scapula upon which the head of the humerus plays, is an instance. A large hollow or cavity in the interior of a bone, is termed a *cave* (antrum), such as that seen in the upper maxillary bone; when of a size smaller, it is known as a *hollow* (sinus), as in the body of the sphenoid bone; and if still smaller, as a *cell* (cellula), as in the orbital process of the palate bone. A small depression is a fovea or fossa. The meaning of the terms canal (canalis), fissure (fissura), notch (incisura), and groove (sulcus), is sufficiently obvious.

Structure.—The proper structure of bone is fibrous in its character; the fibres, in some parts, by being closely aggregated together, constitute a firm and compact substance; but in others they lie so far apart as to enclose spaces or cells, on which depends the porous and spongy appearance of some bones.

The compact substance is so close in its texture, that the naked eye can discover no interstices in it; yet by the aid of a microscope a great number of minute vascular canals become perceptible. In the long bones, these canals are all longitudinal, and maintain a communication laterally with the great medullary canal, and externally with the vessels on the surface of the bone.

The spongy or cellular part presents a multitude of spaces, of various forms and size, all of which communicate with one another, as may be proved by the following experiment; if the end of a long bone, or the surface of a flat one, be perforated, and some mercury poured in, it will be found not only to descend through the cells, but also to flow out through the vascular foramina on the surface. The interior of flat and short bones, then, does not differ so decidedly from that of cylindrical ones, as would at first sight appear. Each presents a cavity, which, at least in the one towards its centre, is a hollow tube, but in the other is divided, by a number of intersecting laminæ, into minute spaces communicating freely with one another.

Some peculiarities are observable in the arrangement of the compact and cellular structure in the different classes of bones. The body of long bones consists chiefly of compact substance, but the inner side of the tube is rendered rough by projecting filaments and lamellæ; towards their extremities, the compact substance is gradually reduced to a thin lamella, or layer, encasing the bone, the interior of which consists altogether of cells communicating freely with the central cavity.

The two surfaces of the broad and flat bones are compact in their texture, the interval between them being made up of areolar or spongy substance. This is usually called *diploë*. In its original acceptation the term diploe (διπλοος double) was applied to the two plates or tables of the cranial bones, together with the intervening cellular structure; subsequently it was restricted to the latter part alone; but it is now commonly extended to the loose tissue of all broad and flat bones. The internal table of the cranial bones is more dense than the external, and, from being also more thin and brittle, it is called *vitreous* (tabula vitrea). The short bones are made up for the most part of spongy substance, encased by a thin lamella of compact tissue. These differences arise altogether from the mode of aggregation and arrangement of the osseous particles; for, on examination, the composition of both is found to be the same, being made up of the same elements, viz. a cellular base, in the areolæ of which is deposited a peculiar earthy salt.

These constituents may be separated, so that each may be examined by itself. If a bone be macerated for some days in a dilute acid, the saline, or inorganic part is removed, whilst the organic remains; the bone is thus rendered soft and flexible, but retains its form, its weight being diminished in proportion to the quantity of saline matter taken up by the acid: when reduced to this state, it presents no appearance of any particular arrangement of fibres, but by a continued maceration in water it may be resolved into layers, each of which will be found to consist of a series of fibres aggregated together. If the process be still continued, the fibres become swollen and softened, and present an areolar texture, analogous to that of cellular tissue in other parts of the body. This then may be considered as forming the nidus for the deposition of that inorganic substance on which the solidity and firmness of bone depend. If a cylindrical bone be examined in this way, its central portion is found to consist of several laminæ, super-imposed one on the other: the external one is continuous throughout its whole extent, forming its general envelope; but those subjacent to it, as they pass from the centre, become gradually thinner, and turn inwards towards the axis of the bone, becoming continuous with the lamellæ which divide it into areolæ or cells (cancelli, lattice-work). In the flat and irregular bones, the compact structure which encloses them externally sends off filaments and plates to divide their interior into cells.

26. By long continued boiling, as is well known, a large part of the animal matter of bone is extracted, and a solution obtained, which concretes on cooling into a gelatinous mass. Again, if a bone be exposed to heat so as to expel all the animal matter, it is rendered brittle and light, but still retains its form; but if the heat be raised until the bone becomes red, it undergoes a semi-fusion, as occurs in other earthy substances under the same circumstances. The analysis of bone affords the following results.

According to Fourcroy and Vauquelin.

Animal matter	51
Phosphate of lime	37.7
Carbonate of lime	10
Phosphate of magnesia	1.3
	100

According to Berzelius.

Cartilage	32.17
Blood-vessels	1.13
Fluate of lime	2
Phosphate of lime	51.04
Carbonate of lime	11.30
Phosphate of magnesia	1.16
Soda, muriate of soda, and water	1.20
	100

The general results of these analyses serve to show that the fibrillæ into which bone may be divided by maceration, consist of a cellular tissue, containing in its areolæ a quantity of earthy salts.

Respecting its ultimate fibre, several fanciful notions have been entertained by different persons. Thus, it was considered by some to consist of absorbent vessels, filled with phosphate of lime. Others thought it to be made up of lamellæ and fibres, between which was interposed an osseous juice, &c. Such gratuitous assumptions serve no other end than to lead inquiry out of the true path, and to retard, instead of promoting, the progress of useful knowledge.

Process of Ossification.—Of all the systems of organs, the osseous is that which arrives latest at its full period of developement, the progress of ossification not being fully completed in the different parts of the skeleton until about the sixteenth or eighteenth year; sometimes even still later. From its first commencement to its final completion, the ossific process runs through three distinct states or conditions, viz. the mucous, cartilaginous, and, finally, that of solid bone. But though these succeed one another regularly, it would be a mistake to suppose that the mucus becomes hardened into cartilage, or the latter solidified into bone, by any process similar to transformation; the facts observed by no means warrant such an inference. The change coincides with an alteration in the mode of nutrition in the part, in consequence of which bone is deposited in place of cartilage.

The embryo, at the earliest periods in which it has been examined, presents no distinction of parts, all being equally soft and homogeneous. So, at least, it has appeared to the greater number of those who have investigated the subject. Sir E. Home, however, states that certain parts are distinguishable, even so early as the eighth day after conception. Towards the fourth week, the consistence of the parts corresponding to the future skeleton is sufficiently increased to admit of their being distinguishable from all others, and their outline defined. The vessels, at this period, convey and deposit gelatine, the basis of the cartilaginous state, which appears to be completed about the eighth week; for it is about this period that the deposition of bone begins in some places. The cartilages being temporary substitutes for bone, differ from it in many respects. They present no appearance of fibres or vessels, have no internal cavity or medullary tissue; they are solid and homogeneous in their whole extent, but possess the outward form of bone, and are invested by a fibrous envelope analogous to that of bone (perichondrium). There is another peculiarity which deserves notice: all those parts of the cartilage which are intended to be replaced by flat bones, viz. of the skull, face, and pelvis, represent a continuous layer, without any perceptible boundary or distinction, and the fibrous envelope passes uninterruptedly over the entire surface; but the femur, tibia, clavicle, and humerus are quite distinct and accurately defined: the latter, it will be recollected, are ultimately to be connected by ligaments, and contribute to form the movable articulations; the former still continue to be united by cartilage. About the eighth week, the cartilage, which, for a certain time, more or less in different instances, occupies the place and performs the functions of bone, becomes hollowed into irregular cavities, and shortly afterwards into canals lined by vascular membranes, and filled by a mucilaginous or viscid fluid; at this period a red dot appears at some particular point, and ossification immediately commences. The spot first ossified (*punctum ossificationis*) is always situated within the substance of the cartilage, never at its surface. Bichât was of opinion that the vessels were not developed at this period; that they existed before, but circulated only white fluids, and then for the first time began to admit red globules; but, be that as it may, the change is marked by the admission of blood into the interior of the cartilage, and the deposition of calcareous matter, both appearing to be coincident. The cartilage appears red and injected, where it is in close contact with the ossified points; more externally it is somewhat opaque, and marked by grooves or canals; in the next remove it retains its original character, presenting, however, in a few points, some vascular canals directed towards the centre of ossification. As the process proceeds, the osseous point increases, as well by additions externally, as by interstitial depositions; whilst the cartilage, as it becomes excavated by canals and cavities lined by vascular lamellæ, diminishes gradually as the bone increases, and finally disappears, being as it were supplanted.

This is to be considered as the general outline of the process of ossification. The time of its commencement and completion varies considerably in different parts of the skeleton. The bones first formed are those which enclose the central organs of circulation, and of the nervous system, the vertebræ and ribs being developed very early. The long bones, viz. clavicle, femur, and tibia,* present along the centre of their shaft a broad ring of bone at the earliest moment at which their outline can be traced, constituting an exception to the general principle, that bone is deposited in the first instance in a bed of cartilage. The jaw-bones and clavicle are also ossified at a very early period; the sternum, pelvis, and extremities, being later, which corresponds with the order of their appearance and the date of their growth in the animal series. From the class of fishes, upwards, maxillæ are developed so rapidly as to be completed very early; so are the clavicles when they exist; whilst the sternum, pelvis, and limbs, grow tardily, and in many instances remain in a comparatively rudimentary state through life.

In reasoning on the phenomena of ossification, too much has been attributed to the periosteum: its importance and utility cannot be questioned, when we consider how frequently partial exfoliations, or even total necrosis of bones, follow as a consequence of injuries of their fibrous investment. Some persons have, however, gone farther than this, and have even contended that it is the periosteum which produces bone, as if the fibrous membrane acted as its secreting organ; but it may be said that it is its vessels which secrete, and not the membrane. The vessels, however, belong to the bone, not to the periosteum;

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* Howship, Med. Chir. Transactions.

and moreover, in many parts, the first ossific deposits take place in the centre of cartilage, and therefore at a distance from that membrane.

SEROUS MEMBRANES.

27. Serous tissue, or membrane, has several synonyms, viz. tissu séreux, membrana serosa, pellucida.—The structures included under this head are so named, because their surface is constantly moistened by a thin, albuminous fluid resembling the serum of blood; their form is that of a shut sac, without inlet or other interruption to its continuity. (Sacculi occlusi, "sacs sans ouverture.")—Each is a delicate membrane, smooth and homogeneous in its structure, and so thin as to be transparent, were it separated from the organs or parts with which it is in contact.

A membrane which, if detached and distended, would resemble a bladder or a balloon, (and such is the fact with regard to the serous membranes), necessarily presents two surfaces. Of these the inner one is perfectly smooth in its natural condition, and lubricated by a fine halitus exhaled upon it, which is occasionally accumulated and condensed into the fluid form. The external surface is rendered rough and flocculent by a number of cellular filaments, which pass off from it to the contiguous viscera, and form the means of its connexion with them. In this class we find grouped together several structures which agree in possessing the conformation and character here indicated, and in exhibiting, when diseased, nearly the same forms of organic change, though no direct communication subsists between them, and each of them is perfectly insulated from the others. The arachnoid membrane, which invests the brain, lines its cavities, and is, moreover, prolonged over the spinal cord, belongs to the class of serous membranes; so do the two pleuræ, which invest the lungs, and the proper pericardium, which encloses the heart; likewise the peritonæum, which is reflected over the different viscera of the abdomen, and the two processes which extend from it upon the testes (tunicæ vaginales). The membrane which lines the anterior chamber of the eye and secretes the aqueous humour, is of the same structure; so is that which encloses the vitreous humour, viz. the hyaloid membrane, and also the capsule of the crystalline lens. The inner or lining coat of arteries and veins presents several points of similitude to those here enumerated.

28. As serous membranes are thus placed within the great cavities of the body, and as they line the inner surface of their walls, and surround, at the same time, to a greater or less extent, the contained parts, anatomists recognise in each of them two portions,—one *investing* the viscera, the other *reflected* upon the walls of the cavity. Thus, in the pericardium, one part of the serous membrane encloses the body of the heart, extends for some way on the great vessels, and then passes off to line the fibrous bag which retains that organ in its situation; so that it forms a single sac, one part of which is doubled within the other. This is strictly true with regard to the pericardium; it is not less so in the case of the peritonæum and arachnoid membrane, though from their extent, and the great complexity of their arrangement, it is not at first sight easily perceived.* It is the investing part of serous membranes which gives to different organs their shining appearance; and as it is very thin, their colour, form, and even the minute inequalities of their surface, are distinctly seen through it, as we observe when examining the heart, brain, lungs, &c. Though these structures appear destitute of fibres, or of any assignable internal organisation, (being what Haller considered them, merely condensed cellular tissue,) still, if any part of them be inflamed, vessels will be traced into their tissue. It requires some care to determine this point with precision; for the vessels which ramify in the subserous cellular web will often appear to run in the membrane itself, when in reality they are external to it.

29. Serous membranes allow a considerable degree of distension during life, as we see in cases of dropsy, and in the state of pregnancy, also in herniæ; and they retract slowly when the distending cause is removed. They exhibit no animal sensibility in their natural condition, but acute pain arises when inflammation is excited. They confine to fixed positions some organs, for instance, the large intestine, the liver, and stomach; in others, as the small intestines, they facilitate movement by means of the smoothness of their surface and the fluid which they secrete. By being reflected from one viscus to another, they necessarily, in the intervening spaces, form folds, in which the vessels are conveniently lodged, and by which they are in a

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* For the description of these membranes, and of their various folds, see the sections on Abdomen, Thorax, Brain.

manner guided to the organs which they supply. It must be evident that these membranes cannot completely invest at every part any of the organs with which they are in contact; each of them will be left uncovered at the points of reflection, and there the vessels can enter them without piercing the membrane, or interrupting its continuity. The folds or duplicatures of peritonæum, termed omenta, mesentery, meso-cola, afford illustrations of what has been here stated. There is but one exception to the general principle above indicated, viz. that serous membranes form shut sacs, without interruption to their continuity or external communication. It occurs at the free, or, as it is technically called, "fimbriated," border of the Fallopian tubes in the female; for there, the serous investing layer is continuous with the mucous lining, and is necessarily open, to give passage to the ovum.

30. Are serous membranes furnished with exhalent vessels to pour out the fluid which moistens them, and with absorbents to take up the surplus or residue of it? The existence of such vessels cannot be demonstrated; it has been assumed, in order to account for the effusion and absorption of fluids, which, until lately, were conceived to be inexplicable on any other hypothesis. It is now, however, clearly demonstrable, that fluids and gases can pass through organised membranes without being conducted across them by exhalent vessels. If a piece of membrane, or, what will answer better, if the cæcum of a common fowl, containing a few drachms of milk, of a solution of gum-arabic, or of common salt, be suspended in a glass filled with water, it will be found that in a few hours the water has entered the intestine, and ascended within its cavity until it overflows at the top. But if the mode of experimenting be altered,—if, whilst the intestine is filled with pure water, the fluid in which it is suspended be rendered specifically heavier by the addition of any saline substance, the direction of the current will be reversed; it will flow outwards from the interior of the membrane. Thus, in the former case, there is a passing into the interior of an organised structure, which M. Dutrochet calls *endosmosis* (ενδος, inward; *ωσμος*, effort); in the latter, the tendency is in the opposite direction, therefore called *exosmosis* (εξω, outward; *ωσμος*). But though the stream seems thus to run altogether from the rarer to the denser fluid, yet we find

that a minor current exists in the opposite direction. If a solution of prussiate of potash be enclosed within the intestine, endosmosis takes place rapidly, and at the same time exosmosis goes on, but in a slight degree, which may be proved by adding a few drops of muriate of iron to the external fluid, when it will be found to have received some of the salt of potash. Gases also percolate membranes, and in a determinate direction.* If a bottle, with a wide mouth, be filled with carbonic acid, and closed at top with a layer of Indian rubber, exosmosis will occur; for the membrane will become depressed into the glass, showing that the carbonic acid escapes out of it, though it has to go contrary to its gravity. If the experiment be reversed, by placing, under a receiver filled with carbonic acid, a bottle containing atmospheric air, closed in by a membrane, endosmosis will occur; for the cover becomes distended and elevated, showing that the carbonic acid has a tendency to pass in that direction in which the atmospheric air is placed. Mere gravity or density does not determine the direction of the current. The chemical composition of the substances employed appears to exert an influence on the result; so also does the galvanic agent.

SYNOVIAL MEMBRANES.

31. *Synovial membrane* (membrana synovialis, tissu synovial).—Under this head are included the lining membranes of all the articulations in the body, together with a great number of secreting sacs, (*bursæ mucosæ*,) which occur in various parts, more particularly in those which are subject to motion and pressure. The secretion poured out by both is quite the same, though the names given to them would imply a difference; and the purposes which they serve in the economy are also the same, viz. that of facilitating motion, and preventing the injurious effects of friction, by means of the fluid which they secrete. Synovial membranes, like those of the serous class, are shut sacs, without perforation or interruption of their continuity. They may be divided into two groups—first, those which are enclosed within joints, and as such are called *articular;* second, those which are applied round tendons, where they slide over projecting bony surfaces, or within sheaths; from which circumstance they

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* Faust and Mitchell. American Journal of Medical Sciences, No. 13.

are often named *vaginal*, or *thecal*, (*θηκη*, a receptacle or sheath).

Articular synovial membranes.

32. Each *articular* synovial membrane lines the fibrous structures which connect the component parts of the joint, and is reflected over the smooth extremities of the bones. If a tendon passes across a joint, as that of the biceps muscle does in the shoulder, or if a ligament lies within it, as we see in the hip-joint, it is enclosed within a tubular sheath derived from the synovial membrane. Membranous processes and prolongations are found in some joints, attached by one extremity, the other being loose and floating. They consist of duplicatures of the synovial membrane enclosing some adipose tissue, together with delicate vessels. These were at one time called glands of Havers, after an anatomist of that name, who supposed them to be of a glandular structure, and to secrete synovia; but this fluid is now known to be produced from the whole surface, and not by any particular glands or follicles. As to the properties of the tissue under consideration, we find it to be, wherever it is situated, soft, thin, pale, and semi-transparent, admitting of distension by the effusion of fluid, as in hydrops articuli, and capable of a slow contraction when absorption takes place. It possesses little or no sensibility in its natural condition, but produces severe suffering when attacked by acute inflammation.

Vaginal synovial membranes.

33. The *vaginal* synovial membranes are so placed with regard to tendons, where they slide upon one another, or over projecting points of bones, that they are named the synovial membranes of tendons. They were formerly considered more analogous to the mucous than to the serous class of membranes, and hence they were called "membranæ mucosæ tendinum." They were also not unfrequently called capsules, sheaths, synovial bursæ. They are enclosed within the sheaths of tendons, and necessarily assume the tubular form, or, rather, each of them represents two tubes placed one within the other, and continuous at their extremities; of these, that which is internal surrounds the tendon, whilst the outer one lines the fibrous sheath which retains it in its situation.

Vaginal synovial membranes, however closely they may agree in structure and use, present many varieties in extent and form. From the large tubes which encompass the great tendons at the malleoli to the small sheath which invests the tendon of the superior oblique muscle of the eye, we trace numerous gradations in their size and general conformation. Their number is considerable; about a hundred pairs may be counted.

Bursæ Mucosæ.

34. Those simple secreting structures, ordinarily known as "Bursæ mucosæ," "mucilaginous bursæ," "subcutaneous bursæ," may with more propriety be called *vesicular synovial* sacs, a phrase which sufficiently expresses their real character and form. They are very numerous; Monro described 140, and Rosenmüller has since considerably increased the list. We find a structure of this sort (which may be considered as a provision to lessen the effects of friction), where a bone moves over a ligament, as the acromion does upon the capsule of the shoulder-joint; where a tendon slides upon a ligament, as that of the psoas and iliacus does over the capsule of the hip; where a bone freely moves beneath the skin, as is the case with the patella; or a prominent process, such as the great trochanter, under a muscle. The form and structure of bursæ may be distinctly traced when distended with fluid, or by inflating them with air. It may then be shown that the cavity of the sac, whatever its size may be, which is exceedingly variable in different instances, is rounded, and that its area is crossed by several partitions dividing it into cellules, none of which however are complete, as they all communicate freely. The wall of the cavity is thin; but of sufficient strength to prevent the diffusion of its contents into the surrounding cellular tissue.

Various gradations may be traced in bursæ, from the more enlarged and complete forms of them here indicated, to that in which they scarcely differ from slightly enlarged or elongated cellules of cellular tissue. In several parts where much freedom of motion exists between the skin and under-lying prominences, whether of bone, tendon, fibro-cartilage, and occasionally of movable tumours accidentally developed, we find the subcutaneous cellular tissue loose and extensible, with its cellules more or less elongated, and their walls more distinct and membraniform; it is so in the neck, where the prominence of the thyroid cartilage slides freely up and down under the skin; and in the extremities, where the prominences of the digital articulations move so constant and freely beneath the tegument. Hence we see how readily bursæ may be produced, as in those cases of unreduced dislocations where the tendons slide over bones; instances of this have been frequently seen in such accidents at the shoulder-joint.

TEGUMENTARY MEMBRANE (EXTERNAL).

35. The tegumentary membranes, as their name implies (*tegere*, to cover,) encase the whole surface of the body, and are also prolonged into its interior, so as to line all those cavities and passages which are in contact with external agencies. This gives rise to a very natural division of them into external and internal, or, in other words, into skin and mucous membrane.

The *skin* (cutis, pellis, common integument, tissu dermoïd,) presents the same form and extent as the body which it covers, and follows all its inequalities, whether they be elevations or depressions. It is a compound structure made up of three layers, viz. corium, rete mucosum, and cuticle.

The Corium.

36. The *corium* (cutis vera, δερμα) forms the basis or principal part of the skin; it is much thicker than the others, and gives them support, as it is subjacent to them. By maceration, its tissue becomes softened, and in a manner unravelled; it will then appear to be made up of dense filaments, crossing in various directions so as to enclose spaces or areolæ. These are of considerable size at the inner or attached surface of the membrane, where granules of adeps project into them, but gradually diminish towards the outer surface, where the texture becomes so close and dense as to be considered by some anatomists as a separate layer, which they have named "textus papillaris." But though there are no adequate grounds for such a subdivision, the term employed expresses a fact which deserves attention, viz. that the surface is not quite smooth or homogeneous, but is studded with a number of minute projections called papillæ.

The corium when examined by itself is pale or dull white, whatever be the tinge which the tegument presents in different races of men or in individuals during life. Any changes of tint which are observed to occur in it, are evidently owing to different degrees of vascularity or of injection, as we see in the state of blushing, and in the rosy hue of health as contrasted with the pallor of disease. Its thickness varies considerably, being in some parts not more than a quarter of a line, in others a line and a half or more. Thus it is very thin in the eyelids, on the mammæ and axillæ; it is thicker at the back part of the trunk than in front, and at the outer than at the inner side of the limbs; and acquires its greatest thickness on the palms of the hands and soles of the feet. As the fluids which it contains evaporate after death, it becomes hard, yellow, and elastic. It is extensible, as we see, when tumours become developed under it, or in pregnancy and hydropic affections; when the distending cause is removed, it slowly retracts. It contains a great quantity of gelatine; on this its capability of being tanned depends; and on its great tenacity its usefulness in the arts when brought to the state of leather.

37. When proceeding to examine the structure of the corium, a small piece may be detached from some part where it is thick and highly developed; for instance, from the bulb of the thumb, or, still better, from the under surface of the heel. By maceration in water for some while, the cuticle and rete mucosum admit of being easily removed; after which, by immersion in hot water for a few minutes, the papillary projections upon the outer surface are rendered more distinct. The inner surface may, in the next place, be sliced away so as to leave merely the outer stratum rendered so thin as to be translucent. If in this state it be placed under the miscroscope, its papillary surface will present the appearance indicated in fig. 4; first, a number of minute conical elevations are seen, most of them slightly inclined towards their summits: next, it will be observed, that these are not scattered irregularly; on the contrary, they are disposed in rows or lines, *h*: as here drawn, the lines appear to be straight, but in their natural position they represent curves in some parts, as on the bulbs of the fingers; they are more or less oblique in others, as in the palm of the hand; or they are transverse, as on the wrist. " These conical papillæ (observes Prochasca) are disposed in curved lines, so that on each line there is a double row of papillæ, between which minute holes are observed, corresponding with the pores visible in the epidermis, through

which, when the hand perspires, we can see the drops of sweat to issue." When looking at a piece of corium so prepared, and placed as here indicated, the summits of the papillæ present an appearance not very unlike that given by the summits of bicuspid or molar teeth, as they are passing through the gums in the infantile state.

The papillæ are thus set in raised lines of the corium, fig. 4, *h*, separated from one another by linear depressions or furrows, *i*. Each raised line, however, is not a continuous ridge ; it is intersected from point to point by transverse lines, *k*. Now the latter may be called interpapillary, from their being interposed between the papillæ ; and the former, interlinear. Each interpapillar furrow will be observed to be slightly depressed at its middle, and at this point there is a minute pore or aperture which gives passage to a sudoriferous duct, as seen fig. 7, *p*.

38. When about to examine the structure of the papillæ, a small slip as thin as it can be taken, may be detached from the edge of a piece of skin, selected as already intimated. A cataract knife will be found useful for such purposes. This slice may be laid on a small piece of glass, and viewed with a single lens, say of the tenth of an inch focus. It will present the appearance indicated in fig. 5, where the papillæ are seen in a row, corresponding with the ridge or linear elevation in the corium, already noticed ; when examined in this way, they do not all appear of the same size. This may be owing to the displacement of the structure from its natural connexions, or to the want of its usual degree of vascular turgescence ; investigations of this kind cannot be conducted without such displacement. Now, in each papilla we can recognise as constituents, 1. the corium raised into a minute summit corresponding with the papilla. 2. Capillary vessels which ramify freely in the corium and around the nerve, but reach no farther than its papillary surface ; for if a part, say a finger, be minutely injected, the capillaries will be found to curve, form arches, and return into the veins. 3. The nerves of the skin, when traced in the subcutaneous adipose tissue, present the same characters as elsewhere ; but as they enter the corium they gradually become softer and present a waving appearance, and this seems to increase as each filament passes into its papilla. It is difficult to say how it terminates, whether it becomes soft and stripped of its

neurilema, or whether it curves and forms a loop; be this as it may, the nerve reaches the summit of the papilla, still without piercing it.

39. *Sudoriferous ducts.*—When noticing the appearance of the papillæ and their arrangement, mention was made of the fact, that in each interpapillar furrow a minute pore existed which transmits a sudoriferous duct. These ducts are easily shown by carefully raising and folding back the epidermis of a piece of skin for some time macerated; as it is slowly drawn back, small filaments will be observed along the line of reflection passing from the corium through the rete and epidermis, as represented fig. 7, *p*. These filaments are the ducts; they are tortuous, they admit of being stretched; when torn, they retract instantly, being highly elastic. They pierce the epidermis obliquely, and terminate by open pores upon its surface, as shown, fig. 8, *r*. As the sudoriferous ducts eliminate from the system an excrementitious fluid,—the perspiration—it will be asked, how do they commence, or whence do they receive this fluid? Is it from the capillary net-work of the corium? If so, the perspiration must exist already formed in the blood. Analogy with other fluids, such as the bile and urine, would lead us to infer, *à priori*, that the perspiration is elaborated by a distinct apparatus, not of course accumulated into a mass, like the secreting organs of the fluids just mentioned, but diffused in the form of separate particles or granules, and lodged in, or just under, the tegument. The duct, after piercing the corium, is traced to a small oblong vascular gland-like mass, which lies embedded in the subcutaneous adipose matter, and which appears to be the immediate secerning organ of the perspired fluid.

40. *Lymphatics.*—Besides the blood-vessels, nerves, and sudoriferous ducts, lymphatic vessels exist abundantly on the skin. Whilst injecting the lymphatics of the lower limb with mercury, the fluid, after filling the glands of the groin, will often pass inwards towards the penis and scrotum, creeping for a while under the skin; they then enter its texture, and ramify so freely as to represent a close and intricate net-work. In this way they are injected, contrary to the natural course of the fluids which circulate in them, and consequently in opposition to the valves if there be any. The valves appear to be complete, and to offer resistance to this process in the primary and secondary

vessels of this order, but at their peripheral and capillary ramifications the valvular apparatus becomes less and less perfect. This is indicated in fig. 9, where no appearance of valves is traceable in the minute branches, though it is sufficiently distinct in the larger efferent vessels passing from the part. All these, however, were injected by Mr. Wilson contrary to the course of the circulation, so that the valves gave no resistance. But it does not follow that they are equally inefficient in the living state when the vessels possess their natural contractile power.

If these vessels be regarded as inhalent or exhalent, how do they commence? Some have said, that they begin with pores, opening on the surface, perhaps from confounding them with the sweat-ducts, or from supposing, according to theoretic views, that there must be openings to admit of the entrance or exit of fluids. The uniform results, however, of injections seem to me to prove that these vessels, like blood-vessels, at their peripheral expansion, which may be regarded as their commencement, form an extensive net-work, and that, whatever passage of fluids takes place into or out of them must be by percolation or imbibition, and not by any capillary movement through pores.

The rete mucosum.

41. The *rete mucosum* appears at first as a glairy exudation between the corium and cuticle, adhering to both, particularly to the former. Malpighi (after whom it has been called rete Malpighi; corpus mucosum—rete glutinosum Malpighianum,) stated it to consist of soft fibres, so arranged as to form a net-work. It is more and more distinct, in proportion as the skin is of a darker hue, so that it is very easily demonstrated in the dark races. When a blister has been applied to the skin of a negro, if it be not very stimulating, the cuticle alone will be raised in about twelve hours. After this is detached, the exposed surface appears covered with a dark coating. But if the blister has been very active, another layer, of a dark colour, comes away with it. This is the rete mucosum, which gives to the different races of mankind their various shades of colour; for the other two layers of the tegument are pale and colourless, as we see when their separation is effected by maceration after death, or by vesicating the living surface.

The nature of the stratum which is thus found interposed between corium and cuticle has given rise to much discussion. Nerves cannot be traced into it, nor has any process of injection shown blood-vessels within it in the healthy state. It appears to be a semi-fluid deposit or secretion, rather than an organised substance: some persons, however, consider it to be a partially organised cellular tissue, containing in its areolæ a dark substance resembling the pigmentum nigrum of the eye; others, as Gautier and Dutrochet, go so far as to resolve it into four layers placed one over the over. In the white races the rete not only loses all colour, but becomes so thin, that it is difficult to demonstrate it; indeed, some eminent anatomists, Bichât, Chaussier, and Dr. Gordon, from these circumstances, denied its existence altogether. But we generally find, on attentive examination, a viscid, semi-fluid stratum occupying the situation of the rete, which, however, is soft and glairy, and, most probably, a secretion produced by the vascular surface of the cutis, or by a special apparatus.

42. M. Breschet is disposed from various considerations to take the rete and the cuticle together, and to regard them as strata of corneous structure deposited upon the corium. "Nous considerons ici comme épiderme toute l'épaisseur de la couche cornée qui est située au dessus du derme, et qui est traversée par plusieurs organs. Le feuillet le plus externe de cette substance cornée constitue la cuticule ou l'epiderme proprement dit de beaucoup d'auteurs." [Recherches sur la structure de la peau, p. 38 note.] We still however shall continue to consider these two lamellæ as sufficiently distinct to retain them as separate structures and to treat of each separately. Though the rete possesses neither nerves nor blood-vessels, (we have already stated that both these reach no farther than the papillar surface of the corium,) still vessels of another kind are recognised by M. Breschet himself as existing in it, and which he considers to be analogous to lymphatics, and to constitute an inhalent apparatus. Now, as nothing of this kind exists in the epidermis, we may consider this circumstance, together with its scale-like texture and difference of colour, sufficient to distinguish it from the rete.

When a piece of skin has been sufficiently macerated to allow the cuticle and rete to be detached (having selected a part where the cuticle is thickened), we can readily see the rete as a distinct layer, particularly if the piece so prepared be placed in spirit, so as to corrugate it a little. The rete, soft and thin, appears as if it had been moulded upon the corium; it takes an exact impression of its lines and ridges and papillæ, as represented in fig. 8. Now when in raising the rete and epidermis, in order to see the sweat-ducts, as shown in fig. 7, we can with the aid of a glass recognise other tubes which are distinguished from the ducts by their smaller size, by anastomosing with one another, so as to form a net-work (which the ducts never do). Moreover, they are not tortuous, nor do they pierce the epidermis. Some offsets or efferent vessels issue from this net-work, and pierce the corium close to the pore which transmits the sweat-duct, and appear to terminate in the venous capillaries of the corium. Within the meshes thus formed is deposited that soft, glairy, mucus-like deposit which gives to the tegument its different shades of colour. Is this product exuded by the vessels here noticed, or by the capillary vessels of the corium; or is it secreted by a distinct apparatus? M. Breschet describes and delineates two distinct secerning organs, one for the mucus which he terms blennogenous (βλέννα mucus, γενναω I produce), and the other, for the colour, chromatogenous (χρωμα colour, γενναω). Those which produce the mucus he describes as minute red glands (petites glandes rougeatres) placed just under the corium, embedded amongst adipose vesicles. From the summit of each a duct issues which pierces the corium and opens upon its surface. The colour-producing apparatus Breschet places towards the outer surface of the corium beneath and between the papillary ridges, and in the depth of the interlinear furrows. The secreted product is poured into the grooves by minute ducts.

The cuticle.

43. The *cuticle* (cuticula, epidermis, scarf-skin) is the outer layer of the tegument. Though very thin in most parts, it becomes thick and indurated in the soles of the feet, or wherever it is habitually subjected to pressure. Its inner surface is connected with the rete mucosum and corium by delicate filaments and by the sweat-ducts, but can be readily separated from them by decoction or maceration : the external surface presents a number of narrow lines or ridges, which make it appear, when examined with a glass, rugged and uneven. This observation seems to have led to an opinion entertained by some anatomists, namely, that the cuticle consists of scales, or lamellæ, disposed like those of fishes or imbricated. The raised lines here noticed,

fig. 8, *q*, correspond with those of the corium; their direction varies, being more or less curved, oblique, or transverse, as may at once be seen by viewing them with a lens upon the ends of the fingers, the palm of the hand, and then at the wrist. These lines are separated by furrows, which are depressed into those of the corium, the rete interposing. These interlinear furrows are intersected by transverse ones, in the middle of each of which we can readily see with the aid of a glass, and often with the unassisted eye, a minute porous depression or infundibulum (fig. 8, *r*), where the sweat-duct terminates. As the epidermis is very thin, its inner surface presents, when raised from its connexions, the reverse of these elevations and depressions: fig. 7, *m*, *n*. This view of it shows that it is so deposited upon the papillary surface of the corium, as to form a mould representing all its elevations and depressions. This is seen more distinctly if the epidermis be slightly corrugated by immersion in spirit or solution of alum. When first exuded, it resembles a thin pellicle of mucus laid upon the surface; it gradually dries and loses its semi-fluid appearance, whilst its lines and ridges become apparent. We can easily trace the steps of these changes, if we note what takes place when it is reproduced upon a part that has been blistered. When the cuticle is detached and laid in water, for some while its inner surface appears smooth and uniform. This is owing to its being stretched by the process to which it is subjected. Moreover, even the pores through which the sweat-ducts pass are invisible; hence many anatomists have denied their existence. Beclard says that he charged a shred of epidermis with a column of mercury, about the weight of one atmosphere, and yet could not perceive any proof of its being porous. This is explicable by reference to a fact above stated with regard to the sweat-ducts, viz. that they are so elastic, that when stretched they retract forcibly, and contract their calibre so as effectually to close the porosities. As the epidermis is insensible, and without vessels or nerves, we may liken it to a dry varnish, which protects the sentient surface of the corium from irritation; moreover, it lessens evaporation, and impedes if it does not altogether resist the absorption of injurious substances.

The hairs.

44. To the skin are attached, as appendages, the hairs and nails.

Hairs (crines, pili) are slender, conical, horny filaments, which in many animals cover nearly the whole body; but in man are principally developed upon the scalp, pubes, and chin. Each hair consists of a stem and a root. The former is free and unattached, of a different colour in different individuals, and tapering towards its summit, which is usually split, or subdivided into filaments; the root is destitute of colour, and widens a little, so as to become hollow and trumpet-shaped, at the same time that it loses its firm, horny texture, becoming softened and gelatinous at its margin. If a hair be plucked out, the part which had been lodged in the skin, fig. 10, is found covered by a thin white tubular sheath which still adheres to it, particularly at its widened edge, to which point it can readily be reflected or drawn down. If examined with a glass whilst still in its place, the stem of the hair being at the same time drawn tightly, as if in the act of plucking it out, the sheath here noticed appears at its outer edge to be continuous with the corium at the point where the hair pierces it. By dividing this tube, and drawing it aside with the point of a fine needle, another membrane, softer and thinner, appears within it, and which seems connected with the rete mucosum. In treating of this subject, we constantly employ the terms "bulb, follicle, papilla." Sometimes the word bulb is used as if it were meant to express the widened and colourless part of the hair, together with its membranous sheath, as they are seen when extracted; this obviously includes two things which are sufficiently distinct. Béclard (*Anat. Gen.* v. 336) takes bulb and follicle as synonymous terms; he says, "The bulb or follicle of the hairs, which Malpighi compared to the vessels in which gardeners plant flowers, is situated in the substance of the dermis, or beneath it." It seems to me better to restrict the word bulb to the root or point of origin of the hair, where it is colourless, soft, and a little enlarged; follicle will then properly express the tubular canal in which it is lodged whilst within the corium, and both will be sufficiently distinguished from the papilla or secreting organ. At the bottom of the tubular follicle is situated a minute conical elevation called the papilla, which is embedded in the subcutaneous cellular tissue, and connected with it by filaments. It is supplied with some minute capillary vessels, and also nervous filaments. Béclard, following out his general views as to the continuity of tissues, views the matter in this way. The outer layer of the sheath is traced down from the corium, the other from the rete; both rise a little at the bottom of the tube to form the papilla: as to the cuticle, it is obviously reflected outwards upon the stem of the hair, and becomes united with its outer surface. The bulbs of the hairs, therefore, observes Béclard, "seem to consist of a small part of the skin, sunk, depressed, or folded upon itself, surmounted by a papilla, which is supplied with vessels and nerves." The analogy between hairs and nails, and a consideration of the mode of implantation and growth of the latter, support this view of the subject.* M. Breschet (*Recherches sur les appareils tegumentaires*, p. 84), observes, that he has not as yet determined (the subject being still under examination) whether the hairs arise, as they are commonly said to do, in a duplicature of the skin, or whether they are secreted by glandular organs placed at the inner surface of the corium (*à la base du derm*). He inclines to the latter opinion. If it be established, then, we shall have to modify our view of the matter slightly, and the facts will stand thus:—The bulb of the hair (fig. 2, *b*) is implanted on the papilla, *c*, which secretes it in the first instance, and supplies materials for its growth, which are added continually to its base, so as to elongate it and cause its protrusion. The papilla at its base is connected with the surrounding cellular tissue by filaments, and by nerves and vessels; whilst by its summit and sides it gives attachment to the bulb of the hair. The investing sheath, already noticed, continuous with the corium and rete at the point of emergence of the hair, dips down, enclosing it as far as its edge, where it is slightly connected with the papilla. But these are not the only means by which it is fixed in its situation: the cuticle dips into the orifice of the follicle for a little way, and so comes into contact with the surface of the hair, on which it is reflected and prolonged, so as to become in a manner identified with its structure.

The difference of colour in hair seems to depend, according to Vauquelin, on the presence or absence of a coloured oil. He found in black hair a substance resembling mucus, and which appears to be a modified albumen, with two oily matters, one colourless, the other a greenish black tinge, and rather thick. He obtained also in his analysis phosphate and carbonate of lime, oxide of manganese and iron, sulphur and some silex. In red hair the iron and manganese exist in less quantity, and the coloured oil is of a reddish tinge. In fair hair the coloured oil is less; in that which is perfectly white it is altogether colourless. The saline substance appears to be that which imparts the colour to the animal matter or oil: we know that hair admits readily of being dyed whilst still growing, or after it is cut off.

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* A plan of this arrangement, supposing it correct, is given, fig. 10. 1.

The nails.

45. The *nails* (ungues) are horny lamellæ, or scales, placed at the extremities of the fingers and toes, on their dorsal surface. The root of the nail, which is about one-fifth of its length, is thin and white, dentated at its margin, and received into a groove, or sulcus, in the corium; its external surface is convex, and marked by some slight longitudinal lines running from behind forwards. At the posterior, or attached extremity, a small portion will be observed, differing in colour from the rest, and usually called "lunula," from its form: the free extremity of a nail is its thickest part, and projects for some way beyond the end of the finger. The mode of connexion established between the nail and the tegument is as follows:—The subjacent part of the corium, fig. 11, 1, thick and red, is surmounted by a number of papillæ, placed in linear series on every part of it, except that beneath the lunula. The under surface of the nail is at the same time soft, and marked by narrow grooves, fig. 12, intended to lodge the papillæ just noticed, and to become intimately connected with them: again, its posterior extremity is received into a sulcus in the corium, fig. 13, which at this point is stripped of its epidermis; but the latter, at the root of the nail, dips into the sulcus and becomes reflected on its upper surface, forming a smooth, superficial lamella upon it. At the free extremity of the nail the epidermis, after covering the end of the finger, is reflected on its under surface, becoming identified with it. Finally, the disposition of the epidermis along the sides resembles, for a short way, that which takes place at the root; but further forwards it is reflected in the way that obtains at the free border of the nail.

In fig. 13, by a vertical section of the last phalanx of the thumb, the relation of the cuticle and corium to the nail, and of the latter to the papillæ, is shown. At fig. 14, an enlarged view of the papillæ is given, and of the loops formed by the vessels within them.

Hairs and nails, with the analogous textures, feathers, wool, claws, and hoofs, in different animals, form a section by themselves under the head Corneous, or Horny tissue. They grow and increase by deposits at their base of a glairy fluid or semifluid matter, resembling mucus or modified albumen, which gradually concretes and becomes harder as it is pushed forward and protruded.

TEGUMENTARY MEMBRANE (INTERNAL).

46. The internal tegument, or mucous membrane, is differently named by writers, tissu muqueux, Bichât; membrana mucosa, villosa, mucipara.—The tegumentary membrane, as has been above stated, is not confined to the external parts of the body; it is prolonged into their interior, where it serves a corresponding purpose; but in this situation it presents some important modifications in its character; and, from the nature of the fluid which covers and moistens it, receives the name of "mucous membrane." From the lips and nares, it extends along the whole length of the alimentary canal, as well as into the different follicles and excretory ducts which open into it. The larynx, trachea, bronchi, and air-cells of the lungs, are lined in the same way by a mucous membrane; and, as the whole forms a continuous surface, it has been named by Bichât, the "*gastro-pulmonary mucous membrane.*" A similar mucous surface may be traced from the orifice of the meatus urinarius, along the urethra, bladder, and ureters, to their termination in the tubuli of the kidney; also into the vasa deferentia, from which it is probably continued into the tubular structure of the testes in males. In the female, it is prolonged from the vagina into the uterus, and thence into the Fallopian tubes to their termination. This continuous tube forms the "*genito-urinary mucous membrane.*"

Between the two great divisions of the internal tegument here pointed out, no organic connexion or communication exists. The general form of each may be said to be that of a canal, or tube, of considerable extent, but presenting numerous contractions and dilatations, corresponding with those of the hollow organs which they line. Their external surface is rough and flocculent; for it is attached by cellular tissue (sub-mucous) to the contiguous textures. The strength and closeness of its adherence varies in different parts of its extent. In the stomach it is easily separated; from the pylorus to the ilio-cæcal valve it gradually becomes more firmly attached, at the valve itself it is less so; but in the large intestine it is again very closely adherent, and so continues to the rectum, near the extremity of which it is comparatively loose. The thickness of the membrane also varies; it is greatest in the stomach and duodenum, and thence diminishes gradually towards the lower part of the small intestine; at the ilio-cæcal valve it increases somewhat; it becomes thinner again along the large intestine (being about half as thick as in the stomach); but it increases perceptibly towards the extremity of the rectum. Its firmness and power of resistance are greatest in the stomach and duodenum, which seems to depend on its greater thickness in these parts.

The colour of the mucous membrane varies in different parts of its extent; to which circumstance, in a great degree, is owing the discrepancy we find amongst writers upon this point. Béclard says it is white, with a reddish tinge; Boyer, that it is yellowish grey, becoming red in the stomach, and reddish in the intestine; Gavard states it to be greyish, with an inclination to red. These statements are too general; for we find that the colour of the membrane is influenced by the age of the individual, by the circumstances which preceded his death, the condition of the thoracic viscera, by the time which has elapsed between death and the performance of the examination, and by the position in which the body has been laid. Hence arises the necessity of distinguishing that which is inherent in the membrane, from what is extraneous to it. For this purpose, a small piece must be carefully dissected off, and held up to the light; it will be found homogeneous, translucent, and of a pale white colour, or greyish, with a delicate rosy tinge. This is the healthy colour and condition of the membrane, when examined by itself after death; and if we inspect the intestine in a subject that has died without disease or disturbance of the abdominal viscera, we perceive, from the outside, some branching vessels creeping beneath the peritonæum, in a direction from the attached to the free border of the tube: a similar appearance will present itself from within, owing to the vessels lying in the sub-mucous cellular tissue. During life, the vessels being necessarily more or less distended with blood, impart a tinge to the surrounding textures; and so the mucous membrane is rendered of a delicate rosy red, varying in degree according to the quantity of fluids circulating in a given part at any particular time. Hence it deepens in the stomach during the digestive process, and this deeper tinge creeps along the intestine as the alimentary mass passes from stage to stage during its progress; for the afflux of blood thus determined now to one point, now to another, carries with it the colour by a sort of derivation.

Plicæ, or *rugæ.*—The inner surface of the mucous membrane presents several inequalities (elevations and depressions) which deserve notice. In the stomach and in the bladder, when cut open, we observe numerous small ridges running in various directions, giving it an areolar aspect: these are termed rugæ; but they are not permanent; they arise from a contraction of the muscular fibres, and consequently disappear when the viscus is distended. In the œsophagus similar folds exist, but all running longitudinally.

47. *Valvulæ conniventes.*—In the small intestine we find folds which are permanent in their existence and fixed in their direction, showing that they depend, not on the contraction of the muscular coat, but on the special conformation of the mucous membrane itself. These are termed *valvulæ conniventes,* and are formed of duplicatures, or narrow plaits of the membrane placed transversely with regard to the axis of the canal, and projecting into its interior. None of these extend round the whole circle—few reach farther than one third of its circumference. Some depart a little from the transverse direction, becoming rather oblique; and a few, of minute size, may be observed to run longitudinally, intersecting the spaces enclosed by those which are larger. When the membrane is detached, and stretched a little, the valves are unfolded and disappear, as the sub-mucous cellular tissue which connects them is torn asunder. The point at which the valvulæ commence is at about an inch below the pylorus, where they are rather small and but slightly projecting; but they gradually increase in size and breadth from thence down to the middle of the jejunum, where they project inwards about two lines; but they gradually diminish along the

ilium, and cease at its lower end, a few oblique or longitudinal lines alone remaining. The term "plica" would better express the character and mode of formation of these projections than "valvula;" for they are merely folds of the membrane, which enlarge the extent of surface by which it comes into contact with the alimentary mass, and increase its absorbing power. The true valves are the ilio-cæcal and the pylorus; for they are contractile (muscular fibre entering into their composition), and exercise an influence on the course of the aliments. The term "valve" is also applied to three or four projecting and permanent ridges which exist in the interior of the rectum.* We shall recur to these when treating of the pelvic viscera.

Villi.—All the elevations hitherto noticed are readily perceived, even on a cursory inspection; they are easily shown in a piece of intestine inflated, dried, and then laid open, or, without any preparation, by merely laying it open; there are others which require a little more attention in order to be distinctly seen. If the mucous surface be held up to the light, or allowed to float in water, it will be found covered with a vast number of minute downy processes, giving it a flocculent appearance. Some persons have likened this to the pile, or soft surface, of velvet; and hence arose the term "villi," by which the projections are known. Their intimate structure has been made the subject of much minute examination, and of not a little controversy; perhaps arising from the opinion, so very generally entertained, that absorption of chyle was effected by the capillary attraction of lacteal vessels, and that the open mouths of these must be placed in the villi. Lieberkuhn concluded (*Dissert. Anat. pathol. de fabricâ et actione villorum intestinorum tenium hominis,*) from his microscopical researches, that each villus consists of a capillary lacteal vessel, and a nerve with a delicate vascular plexus spread upon the lacteal, which becomes expanded into an ampulla immediately after its origin, in the form of a minute pore. Sheldon, Cruickshank, and Hewson, admit generally the existence of a lacteal with vessels and nerves in each villus; but deny the existence of any expansion or ampulla in its interior. We cannot feel surprised at any difference of opinion which may exist concerning the intimate structure of such minute objects, when we find that their outward form is said by some to be round, by others to be conical; whilst a third likens it to a mushroom with a stalk and pileus. All agreed in admitting an absorbing orifice at the extremity of each villus, whatever discrepancy may have existed upon other points. Béclard (*Anat. Generale*), however, after repeating the observations previously made by others, found that these projections are neither conical, tubular, nor expanded at the summit; but that they appear as so many plates, folia, or leaflets, set closely together, and forming a tufted pile. This is the true account of the matter: most of the antecedent observations bear evidence of being undertaken and conducted under the influence of a preconceived opinion as to the mechanism of absorption. There no longer remains any necessity for admitting the existence of pores, ampullæ, or capillary attraction, in order to account for the phenomena. Membranes we know to be permeable by fluids, and in a determinate direction; it matters little, then, whether, with Majendie and Fodera, we adopt the term imbibition to express the fact; or, with Dutrochet, name it endosmosis.

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* Observations on the Mucous Membrane of the Rectum, by Dr. Houston; Dublin Hospital Reports, vol. v.

48. *Mucous Follicles.*—Along the alimentary canal we find, in various parts, minute orifices leading into small follicles, or shut sacs, which appear to be merely depressions into, or inversions of, the mucous membrane (fig. 19, 20). They are embedded in the sub-mucous cellular tissue, and can therefore be readily seen upon the external or attached surface of the mucous lining, if it be carefully dissected away. Their capacity is generally small; in some parts they are simple in their structure, detached, and scattered, as we see in the stomach and duodenum, where they are named glandulæ Brunneri. Towards the lower part of the ilium, and even higher up along the jejunum, they are clustered together into spots (glandulæ aggregatæ, glandulæ Peyeri). In some situations, several follicles open into a common dilated orifice, as into the lacunæ of the urethra and rectum, or into the foramen cæcum at the back of the tongue: finally, several follicles, by being united into bundles of various forms, constitute a compound secreting organ, with ramified ducts or lacunæ, as we see exemplified in the tonsils, the prostate and Cowper's glands. All these structures come under the general head "mucous follicles," for they have been supposed to secrete

the fluid which moistens the surfaces upon which they open. But it is more probable that mucus, like synovia and the serous halitus, is produced by every part of the membrane, and that the follicles elaborate each a distinct product. The secretion of the prostate gland appears to differ as much from that of the tonsils, as the cerumen of the ear does from the sebaceous matter exuded upon the glans penis, or clitoris.

The *structure* of the internal tegumentary membrane resembles that of the external or true skin, so far as that it consists of a corium or dermis, and an epidermis, which is here called epithelium (*επι*, upon; *θηλη*, a nipple or papilla); for when traced inwards from the margin of the lips, it is found to cover the papillæ on the surface of the tongue. A rete mucosum cannot be demonstrated in any part of it. The corium is soft, cellular, and spongy, varying in thickness and density in different parts, as we have already stated. The epidermis is prolonged upon its surface for some way, and may be traced as far as the union of the œsophagus with the stomach. The vagina also is similarly coated as far as the neck of the uterus; but the deeper-seated parts appear to be protected, not by an insensible epidermis, but by the mucous secretion poured out on the surface.

THE VASCULAR SYSTEM.

49. The vascular system (systema vasorum) is made up of a multitude of membranous tubes (*vessels*); some of which convey to the different organs and structures of the body the fluids destined for the maintenance of their functions and growth, whilst others receive from these different parts the effete fluid, and carry it back to the point from which it had set out. As the fluids, in a great number of animals, are thus made to flow, as it were, in a circle, the vessels which direct their course are called *circulating*, and the whole process, *circulation*.

The vessels are divided into three sorts; two of which, the arteries and veins, contain blood (though of a different quality in each); the third, the lymphatics, are filled partly with chyle, the product of digestion, and partly with lymph, the residue of nutrition. As the lymphatics terminate in the veins, and pour their contents into them, they may be considered as tributaries to the venous system. The blood, brought back by the veins to the heart, is conveyed onwards from it, by the pulmonary artery, to the lungs, from which it is returned to the heart again, to be propelled through the aorta into the system at large. Two streams may thus be said to begin and to terminate at the heart: one flowing from it to the lungs by the pulmonary artery, and returning by the pulmonary veins; the other extending through the whole body, and returning by the venæ cavæ. The former has been termed, from its shorter course, the *lesser* circle, and from its destination, the *pulmonary* circle; the latter is, with equal propriety, called the *greater* or *aortic* circle, and not unfrequently the *systemic*, from its connexion with the system at large.

Though some of the older anatomists had conceived sufficiently correct notions of the course of the blood in some parts of the system, yet none of them were able to combine these together, so as to form a connected whole; that was reserved for Harvey, who, about the year 1619, first described the true course of the blood in the different orders of vessels, and demonstrated the correctness of his opinions by a complete series of proofs and experiments.

50. The division of the circulation into the greater and the lesser, or the pulmonary and systemic, as established by Harvey, continued to be universally received, until Bichât (not by any means with a view to question its correctness or truth) adopted another, on physiological grounds. The blood in the branches and trunks of the venæ cavæ, in the right side of the heart and pulmonary artery, being of a reddish-brown colour (*venous*), whilst that in the pulmonary veins, in the left side of the heart, and likewise in the aorta and its ramifications, is red (*arterial*), suggested to the mind of this great physiologist a corresponding division of the circulation into that of the *red* and that of the *dark* blood. According to Harvey, the heart, placed at the commencement of each circle, receives the blood, and propels it forwards, to describe the greater and the lesser course. According to Bichât, the heart must be conceived to be situated at a point intermediate between the origin and termination of each system; of which one (the dark-blooded) begins in the general capillary vessels of the body, and terminates in the capillaries of the lungs; whilst the red-blooded commences in the latter vessels, and ends in the capillaries diffused throughout the body. In this view of the subject, the actions of the lungs, and those

going on in the body generally, may be considered as maintaining a constant antagonism, the one purifying and restoring the blood which becomes vitiated in the other.

Taking the heart as a determinate point in each circle,—that from which each current starts, and to which it returns, we see the tubes which contain the blood commencing by two trunks, the aorta and the pulmonary artery: the former gives off branches, which divide and subdivide, until they become reduced to the minutest capillary tubes in the intimate texture of organs; the latter ramifies in the same way in the lungs. Thus there are two arterial trees, whose trunks arise from the heart; the branches of the one being intended to diffuse the materials of growth and nutrition through the body at large, whilst those of the other convey the exhausted and effete blood to the lungs, to be there renovated.

51. The modes in which arterial trunks branch off, and divide from stage to stage, are various: in the limbs, the branches generally form acute angles with the main artery; within the body, we observe the aorta bifurcate into the common iliacs, and each of these into the two vessels of the same name (internal and external); the renal and lumbar arteries form right angles with the parent vessel; but the superior intercostals issue at obtuse angles. No assignable or fixed proportion seems to exist between the size of the vessel and its branches; from the aorta itself arise the spermatic arteries, which are exceedingly small, and the renal and carotid, which are very large; and between these extremes we see offsets of every variety of calibre. Where, however, a bifurcation occurs, the capacities of the two branches are always greater than that of the vessel from which they proceed; so that the stream of blood, in proportion as it is subdivided, becomes also more diffused, as it flows from a narrower into a wider channel. This was made a subject of particular consideration by those physiologists who, soon after Harvey's time, sought to follow up his views of the mechanism of the circulation. Adopting the opinion which he had taught, that the heart was the sole agent in propelling the blood, it became interesting to ascertain the impediments and resistance which it has to overcome. With this view they examined—the angles formed by the branches at their points of origin,—the number of divisions and subdivisions which took place down to their

termination in the veins,—the proportions subsisting between the calibre of the minor currents, as compared with those from which they proceed,—and, finally, the friction of the blood against the sides of the vessels having been taken into account, the calculations, to determine the question proposed, were carried on with all the precision which mathematical formulæ could give them. From such data, Borelli inferred the heart's force to be equal to 135,000 pounds, whilst Keill reduced it to five ounces.*

The modes of communication between vessels are various; sometimes two of them, from points more or less distant, converge, and meet, forming an arch by their junction, from which issue small ramusculi to the surrounding parts: we observe this along the intestinal canal, and about some of the joints. Very commonly arterial branches are connected only at their ultimate terminations; and under ordinary circumstances neither can be said to receive blood from the other, both being merely a means of supply to the parts to which they run; but if the direct flow in one be cut off, then it will become filled from the other, the current being in the opposite direction to what it was originally, viz. from the branches into the trunk. Another mode of junction is by a short canal extended between two parallel arteries, as in the case of the anterior cerebral arteries; or two of equal size join at an acute angle, and give rise to a third, as do the vertebrals to form the basilar artery.

52. The different communications here noticed are called anastomoses (*αναστομοω*, to make an opening, or communicate; *ανα*, *στομα*, a mouth) or inosculations, which, literally, mean the same thing; yet in their technical application a difference is maintained between them; the latter being used where the union is free and open, the vessels themselves joining so that it becomes difficult to say at what point their opposing currents meet, as is exemplified in the colic, epiploic, and coronary arteries; the former is generally employed when speaking of cases in which the minute branches communicate. When organs receive the materials of their growth and nutrition from two or more sources, the supply is less liable to disturbance or interruption than it otherwise would be; and should an obstruction happen to occur, or be placed designedly upon the current from one quarter; the deficiency will be made up by the others. It is by these means that the circulation is adequately carried on in a limb after the main artery has been tied :—the blood is directed into a new or devious route, finding its way through the anastomoses existing between smaller vessels, and so what is termed "a collateral circulation" is established.

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* Essay on several parts of the Animal Economy, pp. 86—87.

53. The veins, like arteries, present a ramified appearance ; but as the blood flows in them from their extreme branches (which are continuous with those of the arteries) towards the main trunk (vena cava), which opens into the heart, and as the diameter of that vessel is considerably less than the sum of the diameters of the veins which pour their contents into it, the motion of the current within them increases from stage to stage of its progress, because it is made to run from a wider into a narrower channel. The venous system, then, considered as a whole, seems to have been constructed on a hydraulic principle, which materially influences the passage of the blood it contains. It presents, on a general view, a series of cylindrical tubes, commencing in the interior of the different organs of the body, as well as in their remote or peripheral extremities. These, in the first instance, are so minute as to elude vision ; but they gradually increase in size and diminish in number, forming successively vessels larger and larger, until finally all terminate in a large trunk. Though the calibre of any given vessel in the series is larger than that of either of the branches which open into it, yet its diameter is less than the sum of their diameters taken together ; whence it follows, that the diameter of the common trunk is less than the sum of the diameters of the smaller vessels whose contents it receives. Now, when a current flows from a wider into a narrower bed (its level remaining unaltered), it necessarily becomes more rapid as it advances ; and, by an extension of the same principle, when a number of tributary streams open into a channel whose width is less than that of these currents taken together, a certain impetus is given by the mere fact of such an arrangement, which materially aids any other collateral means that may have been devised for expediting its progress.

When describing the veins, it is not by any means necessary to enter into such details as are required when treating of arteries. They, for the most part, take the course of the arteries, and therefore maintain the same relation to contiguous parts ;

but some lie beneath the tegument, particularly in the limbs and neck, being quite superficial. They are more capacious than arteries, and also more numerous, at least in the extremities, where two veins generally accompany each artery; but in the kidney, digestive canal, and testes, the number is equal; and in the umbilical cord there are two arteries and one vein. Abundant provision is established throughout for a free communication between the venous branches,—between the superficial and deep-seated sets at different points, and between the trunks, constituting so many various forms of anastomosis.

There is a part of the venous system so peculiarly disposed, as to form a sort of diverticulum out of the general current, viz. the vena portarum in the liver. It receives the residual blood from the digestive organs, by veins which unite and become continuous with the vessel just named; which, as it enters the liver, spreads out and ramifies within it, somewhat as arteries do. Here are two venous trees (to use a common illustration), with their trunks united to form the vena portarum; the branches of the lower one being diffused amongst the intestines and stomach; whilst those of the upper are lodged within the liver.

Having reviewed the circulating apparatus thus generally, it becomes necessary to notice the peculiarities of each of the three sets of vessels which compose it: as they exhibit not a few striking points of difference, more especially in structure and properties.

ARTERIES.

54. Artery, arterial tissue, arteria.—The term "artery," in its original acceptation, meant a tube containing air, (αηρ, air; τηρεω, to contain,) or some subtile agent, whether called archæus or vital spirits. It was at one time supposed that veins alone carried blood, as they were observed at all times to contain it, in the dead as well as the living; but as arteries were always found empty after death, they were imagined to be the conductors during life of something more refined and ethereal. Though this hypothesis has been long forgotten, the term to which it gave rise is retained even now, notwithstanding that centuries have elapsed since a very different doctrine has been completely established.

Arteries are usually deep-seated, their form tubular, and each, if viewed from its commencement to its termination, will be found not to taper gradually, but from stage to stage to present a series of cylinders, increasing in number as they decrease in size; for a portion included between any two branches, whether it be one inch or three in length, retains its diameter throughout.

The outer surface of each arterial tube is connected with the surrounding structures by cellular tissue and by vessels and nerves: these are derived from some of the contiguous small branches, and are termed *vasa vasorum*, because they circulate in the coats of the vessels, at least in the two exterior, not being traced into the inner one. Nerves also ramify upon and within their structure to the same extent; being derived, whilst in the cavities, from the sympathetic system, and in the limbs from the cerebro-spinal system. In many parts, as in the neck and extremities, the cellular structure becomes condensed, and forms a cylindrical investment (called "a sheath") for it: which, however, is not a part of its proper structure, as the connexion between them is very slight; moreover, the sheath encloses the vein as well as the artery, and in the neck we see the nerve included also.

55. An artery is a cylindrical and highly elastic tube, composed of three coats or tunics, placed one within the other. In fig. 15, a piece of artery is represented with its coats dissected. The outer coat is reflected in three slips, *s, s, s;* the lower one is thrown down so as to expose a part of the middle coat, *t;* a little higher up, where the outer coat is reflected to each side, the middle coat is dissected away so as to bring into view the inner coat, *u*.

i. The *external* coat is formed of cellular tissue, into which it may be reduced by maceration; its texture is closer where it is in contact with the middle coat, than externally where it is somewhat loose and flocculent: it admits of considerable extension, as we see when a jet of water is forced by a syringe into a piece of artery detached and tied at one end; it retracts again when the distending cause is removed; in this it follows the middle coat: its fibres, when separated by tearing them slowly, seem to be for the most part oblique and to cross diagonally; on this its firmness mainly depends, for we know it to be so tough, as not to be divided by a hard ligature placed on the vessel, and so firm, as alone to resist the impulse of the current when the other coats are divided or torn.

ii. The *internal* coat not only lines the arteries, but is continued into the ventricles of the heart; hence it is sometimes called the common membrane; and as it is smooth, and moistened by a fine halitus, which appears to be poured out upon its surface, it is by some considered analogous to serous membranes, and named accordingly. It is thin, homogeneous, and transparent, and so fragile as to be easily torn. Its inner surface is at all times in contact with the blood, the outer being in close union with the middle coat. At each ventricular opening it forms three folds, whose base, or line of attachment, which is convex, is situated at the point of junction between the artery (aorta and pulmonary) and the corresponding ventricle; whilst their free and slightly concave border projects upward into the artery, one surface looking towards its axis, the other resting against its side in the relaxed condition; but when distended with blood, they bulge or project downwards, so as to become convex when viewed from the ventricle, and concave from the artery. Each valvular fold thus disposed encloses a minute stratum of cellular tissue as its bond of union, and is bound down to the middle coat at the margin of one of the convex processes which it presents at its commencement: in the free margin of each is a small granule, called "corpus aurantii" or "sesamoideum." Such are the *sigmoid* or *semilunar* valves, which prevent the reflux of the blood from the arteries back into the ventricles.

iii. The *middle* coat (called also muscular, fibrous, elastic) is that on which the most striking peculiarities of arteries depend. At its commencement it presents, in both vessels (aorta and pulmonary artery), not a straight border, but rather one which is scolloped by three notches into three processes, which pass down to the margin of the ventricle, but are not identified even by their tips with the fleshy fibres. It consists of pale, straw-coloured fibres, coiled obliquely round the circumference of the vessels, but none of them forming a complete circle. If an artery be stretched transversely, it will recoil and resume its original diameter; if elongated, it will retract. These are direct proofs of elasticity. When an artery no longer carries blood, as, for instance, when a ligature has been applied upon it, the part beyond the ligature will contract, its tube will become obliterated, and finally, by an alteration in its mode of nutrition, will degenerate into a mere fibrous cord. This indicates a contractile power different from that resiliency which characterises structures simply elastic, and has been termed contractility of tissue, to denote that it is in some sort a vital property. The coats of arteries resist the effects of maceration for a considerable time, and yield on decoction but little gelatine, and no fibrine: hence the structure of their middle coat has been assimilated to that peculiar substance called "tissu jaune"—"élastique," which forms the ligamenta subflava of the vertebræ, and the cervical ligaments in the lower animals. These physical and chemical properties constitute a marked line of distinction between the middle coat of arteries and muscle; but in some particulars, more especially in its vital properties, it manifests several points of resemblance to the muscular structure, so that it seems to constitute an intermediate link between it and the fibrous or fibro-cellular tissues.

56. That property of arteries which is here indicated, and which enables them to contract towards their centre, without having been previously distended, has been the subject of many controversies amongst physiologists. It has been variously denominated, by different persons,—tonicity, vital force, contractility, &c. The whole controversy may be reduced to this —Are all the phenomena of extension and contraction that are presented by arteries attributable solely to their elasticity? Haller, Bichât, and Majendie, have taken the affirmative side of the question; Hunter, Sœmmering, Thomson, and Home, the opposite. A decided difference of opinion between such high authorities affords abundant evidence of the difficulty of the subject, particularly when we consider the great attention which they have severally paid to it, and the many experiments which they performed with a view to arrive at some satisfactory conclusion. Bichât's arguments against the irritability of arteries are as follow:—1. Mechanical or chemical irritants applied to their external or internal surface, determine no contraction in them; nor, when divided longitudinally, do the edges of the incision become everted, as occurs in the intestines, or other irritable tubes. 2. When separated from the body, they mani-

fest no signs of contractility: if the finger be introduced into a vessel, it is not compressed. Galvanism produces no contraction; and if any is caused by the application of an acid, it is attributable rather to its chemical action on their coats than to any vital power in them. "The arteries," says Majendie,* "nowhere present any indication of irritability; they remain immoveable under the action of sharp instruments, of caustics, and of the galvanic current."

These results are not by any means conformable with those obtained by other physiologists. Dr. Thomson † "succeeded in producing complete contraction, by irritating, for some time, though gently, with the point of a needle, the small arteries in the web of a frog's foot." The same effect was also produced by weak volatile alkali; but when a saturated solution of common salt was applied with the point of a hair pencil, "the arteries, instead of being contracted, as they had so uniformly been by the application of ammonia, were actually and sensibly dilated."‡ Again: "when the capillaries are stimulated by the direct rays of the sun, by the application of gentle friction, or of spirits of wine, the velocity of the blood in them is immediately increased."§ The application of electricity has determined marked contractions in arteries, as has been observed by two Italian physiologists, Giulio and Rossi; and Sir E. Home succeeded in producing the same effect by irritating a neighbouring nerve. These direct proofs of the irritability of arteries derive additional support from several pathological facts. "The increased pulsation of the larger vessels supplying an inflamed part, sufficiently evinces their increased action."‖ Thus, if paronychia occur in one of the fingers, the corresponding radial artery will pulsate more strongly than that of the opposite hand. In cases of hemiplegia the strength of the pulse is diminished at the affected side, though it remains quite natural at the other; a proof that the arteries possess a power independent of the heart, and which is attributable to their irritability. The degree in which these two properties of arteries, elasticity and irritability, are manifested, differs according to the size of the vessels; the larger are more elastic, the smaller more irritable;

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* Physiology, p. 415.
† Lectures on Inflammation, p. 85.
‡ Eod. loco.
§ Wilson Philip on the Vital Functions, p. 285.
‖ Thomson, loc. cit.

and this latter property is more or less subjected to nervous influence.

The experiments of Dr. Thomson, above cited, cannot be considered as conclusive evidence that arteries are really irritable, at least in that sense in which muscles are known to be so. Even were it established that the capillaries are contractile on the application of stimuli, it would not follow that the arterial tubes which extend from the heart to these, are irritable or muscular. Pain is necessarily produced by irritating substances; pain and fear soon influence the circulation; the former will at first quicken it; the latter, from its depressing effect, will soon diminish its rapidity. Besides, it may be objected to all chemical agents, that they must act on the delicate tissues in which the vessels are enclosed, and upon their coats, if not upon their contents.

Whatever differences of opinion may exist on this much-litigated subject, few will deny that arteries assist, in some degree, in carrying on the circulation; for we know that they appear before the heart in the human embryo; and in several of the lower animals, in which there is no heart, the vessels alone propel the fluids. In fishes there is no systemic ventricle; in reptiles the arteries contract and propel the blood after the heart has been removed; and even in warm-blooded animals the blood has been observed moving freely in the capillaries, after all connexion with the heart had been cut off by a ligature on the aorta.* The circulation goes on in those acephalous monsters in which a heart has not been developed. Inferences drawn from a consideration of the structure and functions of the lower animals cannot always be extended to those of more complex and perfect organisation, as the analogy between them may not be sufficiently close to warrant the application; but from a general view of what has been stated with regard to the circulating system, we may conclude, that when the heart exists, it exerts a decided influence on the circulation; that by its action the stream of blood in the arteries moves on, not continuously, but in jets; and that it flows uninterruptedly, though the leading arterial trunks have become ossified. The vessels also have a part to perform, as is evident from the fact that they can propel the blood after the heart has ceased to act; and so the heart and arteries may be considered as associated in the performance of a special function, each being to a certain extent endued with an independent power: one acting by direct propulsion, the others assisting by their vital force and elasticity.

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* Inquiry into the Laws of the Vital Functions, p. 219, by Wilson Philip.

57. *The pulse.*—The flow of blood in the arteries determines a peculiar phenomenon, called *pulse.* The number of arterial pulsations in a given time, varies according to the age, sex, and constitution of each individual; but, setting aside these, and all other variations dependent on different circumstances, in health as well as in disease, when we come to inquire what is the change sustained by arteries during their pulsation, and what is the cause of the change, we find that even on these preliminary questions a considerable difference of opinion exists amongst physiologists. According to Mr. Hunter,* "arteries, during their diastole, increase much more in length than width. It is, however, the increased diameter that is perceived by the touch. This increase is so manifest as to be felt or seen, and produces what is called the *pulse.*" According to Dr. Hales,† "at each systole of the heart the blood in the arteries is propelled forward with an increased impetus, thereby dilating the canal." Dr. Thomson's opinion is nearly to the same effect:—"The pulsation of arteries is derived entirely from the dilatation and elongation which they experience from the blood impelled into them by the systole of the heart."‡ Haller, in one part of his Elements, attributes the pulse to a dilatation of the arteries, but subsequently admits that the dilatation cannot be perceived, and that it is only inferred from the sensation communicated to the finger. Bichât, during the progress of his researches, frequently examined the condition of denuded arteries; and, as he could not observe any adequate dilatation in them, he came ultimately to the conclusion that the pulse was attributable to a locomotion in the whole artery, ("un mouvement de totalité,"§) which causes it to spring against the finger during the systole of the heart. Yet he still inclines to admit a dilatation in some degree:—"Quant à la dilatation, elle est *presque* nulle dans l'état ordinaire." It is scarcely neccssary to allude to the hypothesis

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* On the Blood and Inflammation, p. 23.

† Hæmastatics.

‡ Lecture on Inflammation, p. 63.

§ Anatomie Générale, tom. ii. p. 335.

of Dumas,* that arteries are endued with a power of active dilatation, which enables them to expand, to receive the blood which is about to be propelled into them. The late Dr. Parry,† of Bath, assisted by Mr. Norman, made a great number of experiments to determine the condition of arteries during their pulsation. Whilst prosecuting his researches he laid bare fifty-five of the larger arteries in horses, sheep, and dogs, "yet could not by any mode of scrutiny detect, in a single instance, the smallest dilatation or contraction corresponding with the systole or diastole of the left ventricle of the heart." It is more than probable, as Dr. Wilson Philip has remarked, that the mode of measurement adopted in these experiments was not sufficiently delicate to ascertain the point with precision; for Dr. Hastings found that a ligature placed round an artery was tightened at each contraction of the heart. It appears, then, that the weight of testimony and authority inclines to that opinion which attributes the pulse to a dilatation and elongation of the artery, consequent upon the systole of the ventricles. It cannot be said to be altogether dependent on that cause; for if it were, no difference could exist in the state of the pulse in the corresponding arteries in different limbs, neither could it be raised above par, as we frequently find it, in a vessel leading to an inflamed part, nor depressed below it in a paralytic limb. It has hitherto been admitted, that the pulsation of arteries, no matter how near or distant they may be from the centre of the circulation, occurs at the same moment, being synchronous throughout the body; but some recent observations made by Dr. Corrigan and others, render it probable that a retardation takes place; the pulse in the posterior tibial artery, for instance, being later, by a minute interval, than that in the femoral or iliac.

58. *Developement.*—The formation of the vascular system has been examined of late years with the greatest attention by several physiologists, particularly by Meckel, Serres, Home, and A. Thomson, whose researches have thrown considerable light on this rather complex subject. Meckel has directed his inquiries for the most part to the following points:—to ascertain the parts of the system which are first developed; the ar-

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[*] Physiologie, tom. iii. p. 314.

[†] Essay on the Pulse.

rangement of these parts in the earlier stages of fœtal life; the relation which exists at different periods between the greater and lesser circulation, the dark and red-blooded system; and, finally, the proportion subsisting between the number, size, and capacity of the different orders of vessels at different periods of life.

It is difficult to determine with precision which part of the vascular system is first developed. But if the analogy between birds and the higher animals be sufficiently close to allow of an inference, deduced from observations on the developement of the one to be applied to the other, it may be stated that the veins of the vesicula umbilicalis are the first which become manifest; for the vesicula umbilicalis in the human embryo corresponds with the membrane of the yolk, or the yolk-bag, in birds; and it is demonstrable, that the veins which issue from the latter are the first that are developed. The vesicula umbilicalis is a minute membranous sac, placed between the chorion and amnios, and greater in size, relatively to the fœtus, the earlier it is examined. It appears to be formed before the new being, which in a manner rests upon it, the vesicula being closely in contact with its anterior surface. The cavity of the vesicle most probably communicates with that of the intestinal canal; but there is evidently a connexion by vessels between it and those of the mesentery up to the second month: these, consisting of an artery and a vein, extend in the first instance from the vesicula to the mesenteric vessels. At the period just referred to, they reach no farther than the parietes of the abdomen, and, finally, they disappear altogether. From their mode of connexion, these vessels are called *vasa omphalo-mesenterica.*

59. At the earliest period at which either structure or vessels become perceptible in the incubated egg, some small rounded vesicles, or rather spaces, are seen in the germinal membrane, which soon become filled with a clear and viscid fluid. Separated from one another at first, they represent so many islets, or rather a chain of vesicles, gradually increasing in number, until they form a net-work, which soon becomes filled with blood in place of the fluid previously contained. The minute radicles thus formed gradually unite to form branches, which coalesce and form a trunk—the omphalo-mesenteric vein. These are properly but rudimentary vessels; they

have no proper coats, they are merely canals hollowed, as it were, in the texture of the membrane, like the canals observed by Sir E. Home in a clot of blood, marking out the course of the vessels about to be developed within it. The substance of the membrane becomes thickened along the course of these canals, and forms the first rudiment of their walls; and then the process of developement goes on progressively, though slowly. When the omphalo-mesenteric vein is thus formed, it turns from below upwards, situated anteriorly with regard to the body of the embryo, and terminates in a vein which ascends perpendicularly, and presents a dilatation at the point where the heart is ultimately produced. From this the aorta issues, and distributes branches to the different organs of the body; the accompanying veins being formed nearly at the same time, and also the omphalo-mesenteric artery. It is more than probable that the umbilical vein and artery are developed in the same order as the omphalo-mesenteric vessels, viz. the vein first, the artery afterwards; for they in a manner supplant them. Though arguments founded on analogy so often lead to error, that it is hazardous to employ them in researches of this sort, we yet may use them for the illustration of our views, if not for their confirmation. During the germination of seeds, the new plant, in the first instance, is observed to derive its support from the farina of the seed, and from the leaflets developed within the cotyledons. When the radicula has shot down, and begins to derive nutriment from the soil, these leaflets perish, and the plant is supplied by its own roots. So the vesicula and its vessels appear to support the embryo until the umbilical veins are formed; after which it withers, and finally disappears, when the latter have established their connexion with the uterus, through the medium of the placenta.

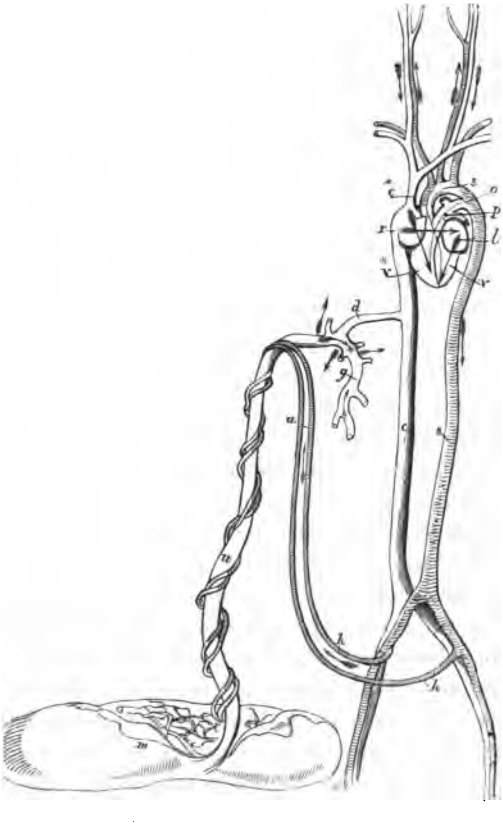
The vein (*omphalo-mesenteric*) derived from the vesicula, opens into the mesenteric vein of the fœtus, which is a primary branch of the vena portæ, so that the latter may be regarded as derived from the omphalo-mesenteric vein. The vena portæ, at this stage of fœtal existence, forms the principal trunk of the venous system, and ascends towards the point afterwards occupied by the heart, where it presents a slight ampulla, corresponding with the auricle; immediately beyond this another slight dilatation appears, and then a third, which represent the auricle, the ventricle, and the primary arterial trunk—the bulbus arteriosus. These vesicular dilatations are separated by slight constrictions. The position of the auricle soon changes with regard to the ventricle; it ascends so as to get to its base or upper part. Each of these cavities, at first single, becomes divided into distinct chambers; but, previously to indicating the steps of these changes, we may here observe that, whilst they are going on, progress is at the same time being made in the developement of other parts of the vascular system. The vena portæ, which originally lies behind the liver, and unconnected with it, becomes connected with the umbilical vein, and, conjointly with it, ramifies in that organ, which then encloses the vein, and, for the first time, becomes a sort of diverticulum, in which the blood circulates before it passes to the heart. Cases have occasionally occurred in which the liver and vena portæ continued to retain the relative position above indicated; that is to say, the vein passed behind the liver without possessing any connexion with it, and opened directly into the vena cava. In these instances a fluid, resembling bile, was found in the gall-bladder, and the inference was at once deduced, that the bile is in all cases secreted from the blood of the hepatic artery, and not from that in the vena portæ. From what has been just stated, these are merely cases of deranged or imperfect developement, and cannot, as such, furnish legitimate data from which any inference can be drawn. But even were it otherwise, the conclusion would be invalid, on the obvious principle, "haud valet argumentum à particulari ad universalem."

60. As the developement of the heart proceeds, the auricle becomes divided into two cavities (but incompletely) by a septum, which projects inwards from its circumference. The division of the ventricles takes place somewhat in a different manner. The right ventricle at first appears like a small tubercle, extending downwards gradually towards the apex of the heart; the septum projects inwards along the line of constriction, which indicates the separation of the ventricular sac into two chambers; it developes also from below upwards—from the apex towards the base. In the next place, along the great arterial trunk a constricted line is observed extending gradually from below upwards, indicating its developement into two vessels—the

aorta and pulmonary artery. They remain, however, connected, and they still communicate during the whole period of fœtal life at their upper part,—the communication being reduced to that short branch or offset which leads from the distal end of the pulmonary artery into the aorta, and which is named the "ductus arteriosus." By means of this communication, the streams which issue from the two ventricles become blended, at least in part; and so the duct has the same effect on the action of the ventricles that the foramen ovale has on the auricles; it makes them, as it were, a single cavity, in so far as the currents which issue from the two chambers become blended after their exit.

61. In reviewing this succession of changes during the progress of developement, we recognise each of them as a temporary or transition stage, which, whilst it lasts, bears a certain degree of analogy to a fixed condition of the circulating apparatus in some of the lower orders of animals. Thus, when in the embryo of a vertebrate animal, a single vessel without any cardiac dilatation runs along the back, it at once suggests the idea of the dorsal vessel in insects. When, at the anterior part of this vessel, an enlargement occurs where the "punctum saliens" is seen, and which assumes the character of a ventricle, it is the analogue of what is found in the higher crustacea. In the next stage, where two cavities exist one just before the other, representing an auricle and ventricle, it corresponds with the condition of the central organ in the mollusca. When the auricle ascends and the ventricle comes forward, the bulbus arteriosus reaching upwards from its base, it is like the heart of fishes, in which it is called branchial or respiratory from its sending the blood into the gills or respiratory organ solely, and therefore discharges the function of the right or pulmonic heart in higher animals. When the auricular cavity becomes separated into two chambers by the growth of the septum, the ventricle still remaining single, it passes into the condition of the organ in the batrachial reptile. In the next place, as the developement of the ventricular septum proceeds from the apex upwards to the base, before it is completed a communication will still remain at this point; the heart in this stage consisting of two auricles and a partially divided ventricle, represents the condition of the organ in the ophidian reptile, and, were its growth arrested at this point (of

which many instances have occurred), that form of congenital malformation will remain through life in which the two sorts of blood are blended, owing to the imperfection of the septum. Lastly, even when all communication between the ventricular cavities is cut off by the completion of the septum, the streams issuing from them are still to a certain extent blended, by means of the current which passes from the pulmonary artery through the ductus arteriosus into the aorta. Hence, until this diverticulum is closed, an analogy will still remain between the conformation of the organs in the fœtus of the human subject and the higher animals with that of the reptile. It is finally cut off at the moment of birth, when the condition of the circulating apparatus in the new being passes from that of the cold-blooded to that of the warm-blooded animal.



62. *Fœtal circulation.*—(Fig. 31 is a diagram of the circulation in the fœtus.)—When the placenta, *m*, is formed, and the fœtus, through its medium, begins to derive support from the parent, the course of the nutritive fluid is as follows:—A vein, *u*, (umbilical,) commencing by branches in the placenta, passes along from it; in its course two arteries (umbilical), *a a*, coil round it, which are continuations of the hypogastric arteries of the fœtus, *h h*; these arteries carry back to the placenta the residue of the blood which had previously circulated in the body of the new being. The umbilical vein, having reached the abdomen, passes towards the longitudinal fissure of the liver, in which it runs from before backwards, sending branches chiefly to the left lobe. At the transverse fissure it forms a direct inosculation with the vena portæ, *g*, so that the currents of the two veins are mingled at this point *, after which they circulate in the left lobe of the liver. The remainder of the blood brought by the umbilical vein is carried onwards to the vena cava by the ductus venosus, *d*, (which is lodged in the posterior part of the longitudinal fissure,) and so through the vena cava, *c*, to the heart.

Were it then required to indicate the course of a given quantity of blood derived from the placenta, and circulated through the fœtus, it would be found as follows:—When brought to the liver by the umbilical vein, part is given to this organ (its left lobe) without mixture, and part after being mixed with that of the vena portæ, whilst the rest, by means of the ductus venosus, is conveyed to the vena cava, and so to the right auricle, *r*, mingled with the blood of the vein.

When arrived at the heart, the current passes directly through the foramen ovale into the left auricle, *l*, and thence into the left ventricle, *v*. From the last-named cavity it is propelled through the aorta, *s*, and its ascending branches, into the head and upper extremities, a small part only being conveyed downwards into the descending part of the aorta, *s* *.

Now, the blood which is brought back from the superior parts of the body and the head, by the jugular and subclavian veins, to the right auricle, is said to pass, (and experiments made by injecting from the umbilical vein upwards, and by the jugular in the opposite direction, with differently coloured injections, seem to prove the fact,) during the earlier periods, without any intermixture with the blood of the inferior cava, into the right auricle, *r*, and thence into the corresponding ventricle, *v* *, which, by means of the pulmonary artery, *p*, propels it partly into the lungs, but chiefly through the ductus arteriosus, *o*, into the descending aorta, and so into the inferior parts of the body. This descending current consists of a less pure fluid than that circulated by the superior aortic branches, as most of it had already circulated through the superior parts of the system of the fœtus, the rest being merely the portion which is conveyed downwards from the arch of the aorta, after having sent the chief part of its blood upwards into the subclavian and carotid arteries. The iliac vessels, into which the aorta divides inferiorly, convey the blood into the lower extremities; but the greater part of it is sent, by the umbilical arteries, to be circulated in the placenta. And as, in after-life, the capillaries of the lungs and those of the general system are opposed to one another, so, during fœtal life, a similar antagonism is maintained between the capillary system of the embryo and that of the placenta. The blood at this early period describes two circles, which intersect one another, and communicate at the heart, so as to describe (to use Bichât's expression) the figure 8.

At first, as has been stated, the blood of the superior and that of the inferior cava do not intermingle in the right auricle; but as the valve of the foramen ovale increases, and narrows the passage into the left auricle, some part of the blood of the inferior cava being prevented from flowing in that course, mixes with that of the descending vein, and with it is conveyed into the right ventricle, so that a gradual approximation is thus being made towards the condition and arrangement of the circulating system which obtain in after-life. The peculiarities which mark each of the organic systems of the fœtus, as well as that now under consideration, lessen as it approaches the period in which it is destined to pass from a dependent, and, as it were, parasitic existence, to a separate and independent one. The derivative passages (ductus venosus and arteriosus, the umbilical vein and arteries), which connect all the parts of the circulating system, gradually diminish, and the placento-fœtal arrangement approximates so nearly to the aorto-pulmonary, that the creature is prepared to pass from one mode of existence into the other, without disturbance or injury to its yet tender and delicate organisation.

VEINS.

63. *Veins, structure of.*—Veins, like arteries, are composed of three coats, which, however, are comparatively thin and flaccid. They are easily distended, admitting of considerable enlargement in the transverse direction; but though susceptible of elongation, they are not so to the same extent as arteries. The *external* coat of veins consists of condensed cellular tissue, but is much thinner and less firm than that of arteries; it is very closely united with the next membrane, which it encloses, viz. the *middle* coat. The latter, thinner and much more pliant than that of arteries, at first appears smooth and even in texture, as if altogether destitute of fibres: they do exist, however; the greater number being longitudinal, some few only assuming a transverse direction. The venæ cavæ, near the heart, are surrounded by well-marked circular fibres; but they are obviously muscular, and continuous with those of the auricle, of which they seem to be a prolongation. The middle coat is more strongly marked in superficial veins than those deeply seated. The *internal* coat is a thin shining membrane, continuous with that which lines the auricles of the heart. In its passage along the veins (those of the extremities) it is thrown into folds at different intervals, which constitute valves, which are so arranged as to allow the blood to flow freely towards the heart, whilst they effectually prevent its regurgitation backwards into the parts from which it had been conveyed. The valves are of a semi-lunar form, the convex border being continuous with the membrane lining the interior of the vessel, the straight or free one projecting towards its centre, where it comes into contact with a similar fold extending from the opposite side; so that both form a complete septum across the interior of the vessel. The valves may be likened to so many minute flood-gates, all inclined in the direction towards which the stream flows, marking thereby its natural course, and constructed so as to prevent its return, at the same time that, by supporting the column of blood which intervenes between them and the heart, and preventing it from gravitating on that which follows, they remove a considerable impediment to its progress along the veins. They are very numerous in the extremities, particularly in the more depending parts, and in superficial vessels. They are said not

to occur in the veins within the great cavities; but they do exist at the termination of some of them, viz. the coronary vein of the heart and the azygos. The lining membrane alone sustains the blood in the bones, the other coats being deficient; this is also the case in the cerebral sinuses, in which the dura mater serves as a substitute for the two external venous tunics, which cease at the base of the skull, where the jugular veins become continuous with the sinuses.

ABSORBENTS.

64. The absorbent vessels are called also lymphatics, vasa lymphatica, absorbent system, système absorbant.—The term "absorbent" means, literally, sucking up; and is used to denote the property (ascribed to certain vessels found very generally diffused throughout the system) of imbibing substances placed in contact with them, and carrying them into the current of the circulation. Under this head are included two sets of vessels, together with a number of nodular bodies appended to them, called glands. The vessels are transparent, their coats being very thin, and appear white when filled with their fluid contents during life; they are very small when compared with the veins whose course they for the most part follow. Like veins, they present a branched or ramified distribution; their radicles commence in the different textures and organs of the body, and gradually converge, forming branches, and finally two trunks, which pour their contents into the veins. When injected, the vessels of this order look like jointed tubes, presenting numerous constrictions which indicate the position of valves in their interior, and enlargements just beyond them. This is shown in a large vessel, fig. 17, and in branches, fig. 9, which marks the contrast between lymphatics and arterial capillaries, as seen in fig. 16: taking the trunk and branches together, they present an arborescent form, like arteries and veins; their ramifications resemble a diffused net-work, and when artificially injected, look like jointed cords.

65. *Lymphatics and lacteals.*—From a difference in the nature of the fluid which the absorbent vessels contain, they are divided into two orders, viz. lymphatics and lacteals. The latter are confined to the cavity of the abdomen, and only absorb chyle, the product of digestion; the former are diffused through the

body at large, and are engaged in that process of absorption which is constantly going on in the various structures of which it is composed.

66. *Glands.*—In different parts of the course of the absorbing vessels, rounded or oval bodies are situated, called ***glands*** (*lymphatic* or *conglobate*), which in the extremities are found usually at the flexures of joints, but in the cavities are variously disposed. A sketch of one of these glands is given, fig. 24, with vessels entering it and issuing from it. They are found in considerable number within the abdomen, in the mesentery, and along the great vessels,—in the thorax at the root of the lungs, and in the mediastina,—in the neck along the course of the cervical vessels. Their size varies from that of a hemp-seed to that of an almond, but they are not so much elongated as the latter. Their surface is smooth, their consistence considerable, which is due to their capsule consisting of fibro-cellular membrane. The vessels, as is evident from the results of injection, on arriving at the glands, become intimately connected with them, and in a manner ramify through their interior; for if some quicksilver be introduced into the vessel, it will soon permeate the whole substance of the gland.

67. *Inferent and efferent vessels.*—The entering vessels are on this account called "vasa inferentia" (fig. 24, *x*). The vessels which issue from the glands appear to arise from their interior by a number of minute radicles, which unite to form tubes, of about the same size as those which had entered at the opposite side. These pass on in the course of the circulation; and as they convey away whatever fluids had passed through the glands, they are called "vasa efferentia" (fig. 24, *y*).

Anatomists are by no means agreed as to the precise distribution of the minute tubuli which are convoluted in the interior of the glands. The inferent vessels on reaching the gland creep for a little way on its surface, and then sink into its interior, gradually subdividing into smaller branches. The efferent vessels issue in the same manner; hence it is frequently asked, are the radicles of both directly continuous within the gland, and is this organ but a closely aggregated plexus? Malpighi showed the existence of cellules in the interior of these glands by injecting them. It is quite certain that, if they be filled with mercury and allowed to dry, the interior cells will be apparent.

when they are cut open. Mr. Abernethy availed himself of an opportunity which presented itself to him of injecting these glands in the whale. The injection was first passed into the arteries, and then by the lymphatics both were found effused into cellules.—May they not have been extravasated?

68. *Thoracic duct.*—All the chyliferous vessels, as well as all the lymphatics, which arise from the lower extremities, from the left side of the thorax, the left upper extremity, and the lateral half of the head and neck of the same side, pour their contents into a common trunk—the "left, or great thoracic duct" (ductus thoracicus sinister vel major, Sœmm.). This is a tube similar in structure, but larger than those which open into it, which runs along the spinal column, from the second lumbar vertebra to the lower part of the neck, where it opens into the angle formed by the union of the left subclavian and jugular veins. The rest of the absorbents, consisting of those which return the lymph from the right upper extremity, from the right half of the thorax, and the corresponding side of the head and neck, terminate in a short trunk, the "right," or "small lymphatic duct," which opens into the junction of the right subclavian and jugular veins. These, it should be observed, are not the only points at which absorbents open into veins. Lippi has shown some of them terminating in the inferior cava, also in the iliac and renal veins.

Lymphatics for the most part follow the course of veins, and like them are divisible into two sets, one superficial, the other deep-seated. They are said to consist of only two coats, perhaps because the external or cellular one is too thin to be satisfactorily demonstrated. The internal coat, or lining membrane, like that of veins, is smooth, thin, delicate, and formed into folds which constitute valves, fig. 18, that allow the contained fluid to pass freely towards the common trunk, but prevent its return. The knotted appearance presented by lymphatics when injected, is owing to the column of the mercury, or other substance employed, being interrupted by the valves. The proper coat, corresponding with that of veins, is dense, firm, and most probably fibrous, though it is not easy to demonstrate the fact, except in the thoracic duct of a horse, or of some large animal. It is slightly elastic, and appears to be irritable; for we observe the lacteals to contract, and force on their contents, when the mesentery is exposed in an animal while the process of digestion is going on.

GLANDS.

69. We find a number of products elaborated from the circulating fluids, which are termed secretions. The organs in which these are produced are called glands (glandula, Αδὴν), from the likeness which some of them present to an acorn. This, however, can with propriety be said to apply to the conglobate class, viz. the lymphatic glands. Various structures have been at different times included under this head. Some of the ancient anatomists, after the example of Hippocrates, included even the brain; and down to the present time the pituitary body and the conarium are spoken of as glands (pituitary and pineal).

70. Glands may be said to be secreting organs which elaborate from the blood special products. This necessarily excludes those two just named, as well as the thyroid body (gland) and the spleen, as we do not know what function they perform; the same may be said of the lymphatic glands, which present the characters rather of ganglia placed in the course of the absorbent vessels.

71. When examining the skin, we found it to be an extended, sentient, and secreting surface; such also is the internal tegument,—the mucous membrane. Now glands are not only dependencies upon these, but also, in the literal sense, productions of them, particularly of the mucous system. Thus some of them are minute cæca, little sacs closed at one end, and at the other opening by an orifice upon the tegument: a plan of this form of secreting organ is given in figs. 19, 20. When constructed in this way, they are termed follicles (ceruminous, mucous, or sebaceous, according to the characters of their secretions). They exist abundantly at the flexures of joints, at the orifices of cavities or passages; they are seen enlarged in their diseased state in acné and sycosis menti. Along the mucous membrane they are found either detached, and therefore termed solitary (glandulæ solitariæ), or collected into groups (g. agminatæ). Suppose for a moment the head of a pin to be pressed against the mucous membrane until a minute piece of it is made to bulge out, it will present to the mind a sufficiently exact notion of a follicle. In some places, for instance in the urethra,

they are lengthened into the tubular form so as to admit a bristle or fine wire for two or three lines; these are called lacunæ.

Follicles are not all single and simple, like those here noticed: we find them in some places aggregated into groups, as in the tonsils, which may be called conglomerate follicles; in others they are placed in rows, their orifices converging inwards from point to point, the secretions from all being evacuated by a single orifice. The Meibomian follicles under the lining membrane of the eye-lids are arranged in several rows running upwards from the free edge of the lids. They present, if laid with the conjunctiva upon a piece of glass, the appearance represented in fig. 21. Some of the rows curve at their distal end, so as to form a communication; at the lower or tarsal end, each row opens by a minute orifice. When viewed through a lens, the lateral follicles of a single row (fig. 22) are seen converging inwards; two or more open into one pedicle or duct, and all these communicate with the surface by means of the single duct seen at the lower end of this elongated cluster.

Proceeding from these simpler forms of glands to those considered complex, we find that they still consist essentially of a prolongation of mucous membrane drawn out, as it were, and lengthened into a tube, out of which offsets issue from point to point, until it assumes a branched or arborescent form as represented in fig. 23, which is taken from a preparation of a part of the parotid gland. From the duct of a lobe, *a**, branches diverge, and from these, as they spread out, others still smaller issue, until finally each ends in a minute closed sac. Here, then, the branching tube of mucous membrane is as much the essential constituent of a compound or conglomerate gland, as it is in the simplest mucous follicle. All the other constituents may be considered as accessories to this fundamental one: the artery *b* * runs upon it and ramifies by its capillary offsets, even to the ultimate follicles; the nerve creeps upon the artery to the same points; and from them the veins and lymphatics issue. All these are as much accessories as the fibrous coat which supports the duct and its ramifications. The sub-maxillary gland and the pancreas are constructed in the same way; so is the liver, which is apparently the most complex of all. It is essentially a ramified duct prolonged from the intestinal mucous membrane. But there appears to be this additional complication in the liver, that the duct, when arrived at the lobules, instead of ending in a simple closed sac, forms in each of them a plexus or net-work, as indicated in fig. 24. This plexus occupies the circumference and area of the lobule; the vein is seen commencing by radicles towards the centre.

However complex the structure of the liver may appear in the higher animals, we find that it becomes gradually resolved into lobes, and these into lobules, and finally into cæcal appendages, as we trace it step by step down from the vertebrate animals through the mollusca, crustacea, myriapoda, arachnida, to the annelida, or red-blooded worms. In the last it is represented by several simple cæca which open into the intestine. Even in some of the lowest division of the animal series, viz. the radiata, cæcal appendages are found which, from their position and relations, are inferred to be the analogues of the biliary organs. It is in this same simple form, viz. a cæcal appendage gradually evolving into an elongated branching tube or duct, that its developement commences in the higher animals.

The pancreas becomes unravelled and simplified in the same way in lower animals. It is still lobed and conglomerate in the shark, and higher cartilaginous fishes; in the osseous, as the cod and haddock, it is represented by numerous cæca, forming a fringe round the commencement of the intestine, and opening separately into it. In cephalopods and gasteropods one or two cæca exist in the same situation, marking the rudimentary condition of the organ.

72. Those who have treated of the structure of glands, adopt, for the most part, the views of Malpighi or of Ruysch. The former considered that the granules or lobules, (acini,) of which a composite or conglomerate gland is made up, are so many follicles, each opening into a common duct. They are so in the salivary glands, but not in the liver; neither are their extremities enlarged so as to present a greater diameter than the branches of the duct which terminates in them. Any enlargement which may appear to exist at these points is in part attributable to the accessory tissues which surround them, such as the cellular substance which supports the capillary vessels and nerves, and partly to the distension caused by injection. Malpighi's opinion, then, as to the intimate structure of glands, is

nearer to the truth than that of Ruysch, who concluded, from his examinations, that the lobules are coils or interlacings of capillary vessels, the arteries being prolonged so as to become continuous with the excretory ducts. Neither of these inferences is tenable with regard to the follicles or the conglomerate glands; both appear to have been deduced from the examination of the kidney, and by some are made still to apply to it; but though the cortical or vascular structure of this organ may be described as formed of capillaries coiled or interlaced, its tubular structure is essentially composed of branching offsets or cæca derived from the ureter, which is a prolongation from the genito-urinary mucous membrane.

ERECTILE TISSUE.

73. There are some parts whose ultimate vessels are so constructed as to admit of a considerable accumulation of blood, causing great distension, and what is termed erection; hence the origin of the term "erectile tissue," (vasa erigentia, tissu erectile,) which is applied to the capillary vessels of the corpus spongiosum, cavernosum, and to those around the vagina and nipple in females. It was formerly supposed that the blood was effused, during the venereal orgasm, into minute cells; for some erectile parts, particularly the corpora cavernosa, when inflated and dried, appear to consist altogether of cellules, formed by septa dividing the interior of the tube into a multitude of minute compartments. This mode of preparing the part for examination is obviously defective; for the vessels contained within the cells are necessarily compressed, and cease to be distinguishable from the fibres which form the septa. But if an injection be passed in by the arteries, or by the dorsal vein, which is the better mode, after having previously, by means of a probe, broken down the valves, it will be found not effused into cells, but contained in a plexus of delicate vessels consisting of minute capillaries communicating with venous radicles, the latter in many places presenting dilatations and free communications. Parts thus organised are known to be peculiarly sensitive; we find that they receive a considerable number of nervous filaments. A structure analogous to that here described is occasionally produced in different parts of the body by a dis-

turbance of the natural formative process, and is commonly known as aneurism by anastomosis.

THE MUSCULAR SYSTEM.

74. The active organs of locomotion are called "muscles" (musculus, à moveo). Taken in their aggregate they form the muscular tissue or substance of the body (tissu musculaire, musculus, *μυς*, *μυες*, flesh). In ordinary language they are known by the name flesh, and necessarily differ widely in colour and consistence in different orders of animals. A muscle is a compound structure made up of cellular tissue for its basis, which encloses in its areolæ fibrine as the essential constituent. Tendinous fibres are superadded in most muscles, particularly at their extremities, forming the means of attachment to the periosteum and bones. Arteries and veins circulate in them the materials of growth and nutrition; nerves give sensation and motion; and lymphatics take up the residue of nutrition. Muscle, then, and muscular tissue or fibre, do not mean the same thing; we must remove all the accessory parts just named in order to get at the fibre, or we must make abstraction of those, and contemplate this alone, when we reflect or reason on its properties.

75. When we look at a muscle dissected, it evidently appears made up of fibres arranged in a defined direction; several of these are observed to be aggregated into bundles (fasciculi), each of which is separated from the rest by a thin lamella of delicate cellular tissue. Each fasciculus admits again of being resolved into fibres, and these into fibrillæ; and the separation may be continued until we at length arrive at some so minute as to be incapable of farther division; these may be regarded, therefore, as ultimate fibres, at least in reference to our methods of analysis. The cellular investment of a muscle may be called its "sheath;" the thin lamellæ which dip between the fasciculi are so many processes derived from it. When we come to the fibrillæ, and find each composed of a tube of cellular tissue enclosing the essential constituent of muscle, we apply to it the term "myolema," figs. 25, 26.

By macerating muscle in water, it parts with the red colour which it possesses in higher animals, and becomes ash-grey, with a slight straw-coloured tint; the water takes up from it the colouring matter, albumen, gelatine, extractive matter, and some salts; after which there remains fibrine with cellular tissue, the latter seeming to serve as the nidus in which the former is deposited.

76. *Muscular fibre — its intimate structure.*—Those who have examined muscular fibre with the microscope differ considerably in the statements which they make of the result of their observations. At one time it was supposed to consist of a series of vesicles, which were oblong or elliptical in the flaccid state, their long axes being in the direction of the fibre; but that when in action, their form changed to spherical, or, if it still continued elliptical, the major axis became transverse: in this way they accounted for the shortening of muscular fibre, the alterations in the form of the vesicles being produced by an afflux of animal spirits conveyed by the nerves. Many men of the present day, who reject this speculation, contend for the existence of globules placed in regular lines along the fibre, as if they were deposited in the areolæ of cellular tissue. Some represent the fibre as a hollow tube containing fibrine. Is it that the object seen appears to be of that form which prepossession in favour of some particular hypothesis concerning muscular action had rendered probable that it should be, or is the difference owing to defect in the instruments used? When examined with a microscope of ordinary power, globules appear to exist; but with other instruments, the fibre resembles a gelatinous thread, soft and homogeneous. Dr. Hodgkin and Mr. Lister, however, with the aid of an instrument, the power and accuracy of which are generally admitted, observed numerous cross lines placed parallel, and in a manner intersecting the fibre at minute distances. Hence some have inferred that the bead-like or globular structure attributed so generally to muscular fibre, is but an optical illusion, owing to the shadows produced by the transverse lines just noticed.

When in action, the fibres, instead of being straight and parallel, are thrown into waving lines, not unlike those seen on a watered riband. In this state the extremities of the muscle approach, it becomes shortened and contracted; its thickness, at least towards the middle part, being increased. Formerly it was contended that muscles acquired a positive increase of bulk during their contraction, and the opinion was supported by experiment. Now, on repeating the experiments with proper attention to accuracy, no such increase can be detected; and it is altogether unlikely that new matter could be imparted or withdrawn at each alternation of action and rest in muscles.

77. Muscles being obviously subjected to nervous influence, we naturally inquire what anatomical relations subsist between the ultimate fibres of nerves and the fibrillæ of muscles. MM. Prevost and Dumas arrived at the following results, after an extended investigation of this subject. When a piece of muscle (the rectus abdominis of a frog, from its evenness and thinness, is the most convenient that can be selected,) was examined with a microscope, after some previous preparation, the nervous branches, on entering its fasciculi from the sides, appeared to give off threads which run between the fibres, and each pair of these is connected by minute parallel filaments running across the intervening muscular fibre. The latter, viz. the transverse filaments, after running a short way in the direction indicated, begin to curve and return to the branch from which they set out, or join, in the form of an arch, with some others. Thus the nervous filaments, after intersecting the muscular filaments, terminate by forming delicate loops or arches, both ends of which are in communication with the brain or spinal cord. Now a muscle is observed to form zig-zag lines when thrown into action; and the angles of inflection, which occur at very minute intervals, correspond with the points at which the nervous filaments impinge upon and cross them. In this way the muscle is shortened, and traction is made upon the point to which its ends are attached.

78. Raspail (Chimie Organique, p. 212) criticises this statement, and expresses a decided opinion that it is altogether untenable. He says it is difficult to conceive how elastic fibres can present such precise angular inflexions as those represented in the drawings of MM. Prevost and Dumas. And in the next place, when nervous fibrillæ approach in size that of the ultimate muscular fibres, the one cannot be distinguished from the other. Moreover, when a flat slip of muscle is laid on a plate of glass, it necessarily is in contact with many points of it; hence, if it be drawn at one end, or excited by a voltaic current, inflexions or zig-zags will appear in the fibres, owing to the resistance given

at the points where they are in contact with the glass. Raspail here assumes the fibres to be elastic, and reasons upon them as such; and also that they are placed upon a dry glass. In such experiments a pellicle of water is usually laid upon it, and confined to the middle of the glass by a simple contrivance. However, as I have not repeated the experiment, I have nothing to offer either upon the original statement or the comment. Raspail observes, that having had many opportunities of examining the movements in the muscular foot of gasteropods, he never saw anything in them like what Prevost and Dumas describe and represent. He constantly saw that the fibres, whilst they shorten, become at the same time enlarged in breadth, so as to present small swellings along their course.

79. Several methods have been adopted to determine these points relative to muscular fibre. Thus the Wenzels made their microscopic observations on pieces of muscle which had been previously steeped in spirit or weak acid. This is evidently objectionable, as the myolema is corrugated and rendered opaque; still they found the fibres to be composed of minute globules placed in lines. Such a mode of experimenting cannot be considered conclusive, as the globules may have been produced by the previous preparation which coagulated any albuminous matter that may have adhered to the fibre, or that which exists in the myolema. The muscular substance used should be fresh,—that of pork answers perhaps better than any. If a small fragment be detached and laid on a piece of glass, it can, by the aid of a fine needle, be resolved in filaments so minute as to be incapable, without breaking them, of being farther divided. A few of the finest and most perfect of these may be separated from the rest without disturbing them from the glass, and placed under the lens. Some of them give the idea of a homogeneous gelatinous thread of a slightly pink tinge; but others seen towards the centre of the field of view, and in better light, exhibit minute extremely close transverse bars, such as are indicated in fig. 25. These appear to be in the myolema, and to be owing to its being thrown into plicæ, as they disappear if the fibre is stretched. Continuing the observation, it will be found that the fibre is not homogeneous or gelatinous; but that it consists of a tube, the myolema, filled with minute globules, as represented in fig. 26. I repeated these observations with Mr. Wil-

son,' the same results were obtained two or three times; and Mr. Bagg made these sketches from what he saw when the microscope was placed before him without knowing what the object was.

80. There are some opposing statements as to the relative size of muscular fibre and the globules of the blood, which may be here noticed. Prochasca concluded the former to be to the latter as 1 to 7. Sprengel, however, states the relative size of the fibre and the blood globule to be precisely the reverse, viz. the fibre is to the globule as 7 to 1.

81. Having proceeded in this discussion thus far, I am unwilling to prolong it, or offer any speculation as to the mechanism of muscular contraction. Still, as I have generally found persons better pleased to have a resting-place for the mind, even though it be but a provisional one adopted until a better can be devised, rather than be left in a maze of incertitude, I may offer one founded perhaps, it will be said, on a slight or remote analogy, yet one sufficiently recognised by physiologists. From what has been already stated, we know sufficient of muscular fibre to reason upon it; we know it to consist of a cylindrical tube—a myolema, (fig. 25,) enclosing minute globules in its interior (fig. 26). We know that all the movements and actions produced by muscles, are owing to that property which their fibres possess of shortening when excited or stimulated. We also know, from numberless facts, that this shortening or contraction of the fibres is determined in the first instance, kept up and regulated by an influence conveyed by the nervous filaments which reach them from the various nervous centres. Now, on what does this influence act, and in what way, assuming for a moment that there is an analogy between it and voltaic agency? We can hardly suppose it to be on the myolema, which is but a delicate or slightly modified cellular tissue; there remains then but one other constituent, namely, the globules, on which it can act. Now, if it be permitted us to suppose that the nervous agency influences the globules of the fibre, as the voltaic is conceived to do the molecules of a piece of metal on which it acts, —that it changes their state so as to render them attractive of one another, or repulsive, or simply quiescent, just as the voltaic can impress a given polarity upon the molecules of a mass, reverse it, or destroy it altogether,—we may conceive that the

fibre shortens when its globules are rendered mutually attractive; and also increased in width. When the nervous influence ceased to be directed to a particular set of fibres, they become quiescent, their particles returning to their neutral or unexcited state; it may then be determined to others whether assistants or antagonists, and so the succession and series of movements is kept up.

82. When seeking to express briefly the distinction between muscular tissue and others, it will not suffice to say that it is fibrous,—for several other structures possess that character which have little else in common with it;—nor that it is of a red colour, like blood, for it is white in most fishes, and in many of the lower tribes of animals. Its true distinguishing character is, the property it possesses of shortening or contracting in obedience to the will, or on the application of a stimulus. This is its essential attribute, and constitutes a broad line of distinction between it and other organised structures. This property has been variously denominated at different times, "vis insita," "irritability," "contractility," and has been at all times a fertile subject of controversy among physiologists; some contending that it is an endowment residing in the muscles themselves; others, that it is imparted by the nerves; whilst a third party takes up an intermediate position, admits the existence of a peculiar property in muscles, but contends that nervous influence is necessary to bring it into action. When a muscle is cut across, both ends retract slowly, and remain permanently shortened.

83. *Muscles, voluntary, involuntary.*—The muscular system is divisible into two parts, which are distinguishable not only by the situations they occupy, but also by their general conformation and functions. One is subjacent to the skin, and composed of a number of separate pieces, of various forms and sizes, all under the control of the will; the other, disposed in the form of a thin tubular layer around the alimentary canal, consisting of pale fibres, which are not influenced by the will. Hence the origin of the division of muscles into voluntary and involuntary, or, according to Bichât, into those of animal and organic life; the actions of the former, being performed with consciousness, serve to keep up our relations with the external world; whilst those of the latter, which are not attended by consciousness, are

confined to the functions of nutrition, or of vegetative life. There is, however, a third group, whose action continues even though consciousness be suspended, during sleep, or in comatose diseases; but which, under other circumstances, are, to a certain extent, influenced by the will, viz. the respiratory muscles, which in these particulars are intermediate between the other two, and are called mixed muscles.

84. *Muscles: their varieties and nomenclature.*—Muscles present numerous varieties in their form, size, and distribution of their fibres; some being broad and flat, like the muscles of the abdomen and the superficial layer of the back; some long and tapering, like the muscles of the fore-arm; some short and compressed, like the masseter and pterygoid. Their extremities or points of attachment are named *origin* and *insertion;* the former being the more fixed point, and that to which it ordinarily draws, the latter being less fixed: the intervening fleshy part is called the *body* or belly. Muscles are arranged in groups, according as they are associated for the performance of special actions; some being flexors, others extensors; some adductors, others abductors. The individuals of each group are called assistants; those which combine to oppose them, antagonists. The nomenclature of muscles is not even yet constructed upon scientific principles; some being named from their position, such as the temporal and occipito-frontalis: some from their form, as the trapezius, serratus, rhomboideus; some from their position, as the pectoralis, brachialis, anconeus; some from the disposition of even their accessory parts, as biceps, triceps; many from their uses, as elevators, depressors, abductors, adductors; and not a few from their points of attachment, as sterno-hyoid, sterno-thyroid. This necessarily gives an unscientific and immethodical character to our myology, and increases not a little the difficulties which beginners find at the commencement of their studies. Throughout this work the nomenclature of Sœmmering is generally adhered to, as being that which is adopted by the most experienced teachers. Chaussier's terms are added to facilitate the perusal of French anatomical and surgical works; and those of Dumas, because they briefly mark the points to which each muscle is attached, but I have in most places Latinised their terminations to make them more in accordance with the other terms employed.

THE NERVOUS SYSTEM.

85. The nervous system, (*système nerveux*,) nervous tissue, (tissu nerveux,) nervus, *νευρον*, may, with great propriety, be said to preside over all the leading functions of the economy; for it would be restricting its influence to a very narrow limit, were we to say that it merely receives impressions from without, and transmits volitions from within: its dominion extends much further. When we see a limb deprived of sensation and motion by an apoplectic seizure, we at once admit that these powers are dependent on nervous action; and we cannot but infer that nutrition and animal heat are equally so, when, at a subsequent period, we find it wasted and reduced in temperature. All persons are aware how the secretions may become deranged and vitiated by injuries of the spinal cord: that of the kidneys, for instance, becomes small in quantity, turbid, and ammoniacal; digestion is suspended by the section of the vagus nerves; and the researches of Le Gallois and Wilson Philip have shown how the circulation is affected by and through the nervous influence. Finally, intellect and reason are instantaneously extinguished if a small fragment of bone be depressed upon the surface of the brain.

86. *Nervous system—general idea of.*—Many persons evince a disposition to compare and contrast objects, rather than formally describe them, perhaps with the view of conveying some general notion of their composition and characters. The nervous system has been dealt with in this way, having been likened to a tree; the brain serving as the root, the spinal cord the trunk, and the nerves as branches: but latterly it has been viewed in a different way; the nerves being considered the roots, as they are known to be formed first, and may, as in acephalous cases, exist, although the central masses are never formed: and lastly, it has been compared to a vast net-work of nerves, interlacing by their ultimate filaments at their peripheral terminations throughout the system, and also becoming united by decussation, or by commissures in the central masses. However vague, and in some respects questionable, such loose generalities as these may be, they serve the purpose of conveying to the mind the idea that the nervous system, though complex and subdivided, forms one whole, all its parts being intimately connected and associated, at the same time that some are placed in subordination to others.

87. *Nervous system, symmetrical.*—When viewed as a whole, the nervous system is symmetrical in the strictest sense. It consists of two lateral halves, which, being disposed similarly on each side of the central line, resemble one another in every particular. Thus, the brain is divided into two hemispheres, each presenting on its inferior surface three lobes; the cerebellum also is divided into two lobes; and the medulla oblongata into two lateral halves, (each consisting of three fasciculi, or bundles of fibres,) the division being established by two grooves or sulci, one on its anterior, the other on its posterior aspect, situated exactly in the median line. These sulci, by being continued along the whole length of the medulla spinalis, divide it also into two symmetrical portions. This symmetrical arrangement extends to the nerves so long as they retain the form of distinct cords; but when, at their peripheral termination, they become expanded into, and blended with, the minute texture of the different organs which they supply, their mode of distribution eludes our research. We can, however, infer that their filaments interlace one with another, so as to form a net-work, by which a complete and free communication is established between them.

Commissures.—Again, when we examine the central masses, we find that each lateral half is connected with the other by certain transverse bands, disposed along the middle line, and which are termed commissures. On this union and connexion between the different parts of the nervous system, by which they become intimately blended at their periphery, as well as towards the centre, the individuality of the animal essentially depends.

The central parts of the nervous system are deeply seated, being enclosed within the spinal canal and the cavity of the cranium. The nervous cords, too, are in a great degree withdrawn from the influence of external agencies by the situations in which they are placed during their course. Their final terminations only approach the surface, where, by being expanded on the internal and external teguments, they communicate to these parts their sentient and tactile properties.

88. *Composition.*—The nervous system is made up of two substances, readily distinguishable by their colour, texture, and consistence. One is greyish, or rather a pale ash-colour, and hence named *cineritious* (substantia cinerea); and as in the

brain it forms an investment for the white substance, it is usually termed *cortical* (s. corticalis). The other substance is of a pure white colour, and from the relation just indicated is called *medullary* (substantia medullaris). It cannot, however, be said with propriety that the one is external, or the other internal, as their position is reversed in different parts of the system. The grey substance invests the cerebral hemispheres, and forms at the same time several masses disposed in their interior; but in the medulla spinalis it is altogether deeply seated. The white substance, on the contrary, is enclosed by the grey in the brain, but becomes the cortex in the medulla. The cineritious substance is more soft and vascular than the other. The difference in these particulars is rendered more striking when the brain is minutely injected. Though the white substance in the natural state, more particularly in the fœtal state and in early infancy, is not much firmer than jelly, it acquires a great degree of firmness by maceration in spirit, and presents at all times a distinctly fibrous appearance. When these two sorts of nervous matter are attentively examined, they will be found to consist of a peculiar substance called *neurine*, deposited in the areolæ, of a delicate cellular tissue. This anatomical element, in its natural condition, is soft and as it were plastic to the touch, and wherever it predominates much, the part will be pulpy, whilst other portions of the structure are comparatively firm, by reason of the greater quantity of cellular tissue which they contain. The colour of neurine presents some varieties, being white, grey, or yellowish, and in some places of a dusky hue.

89. When a thin layer of nervous substance is examined with a microscope, it presents the appearance of small granules, placed in lines more or less regularly; but their form and size are liable to vary. These have been taken by some observers for globules, and have formed the basis of many speculations concerning the nature of nervous action: by some they are said to resemble much more nearly the delicate flakes observed in coagulated albumen. According to the analysis of Vauquelin, neurine consists of

Water . . .	80·00 parts.
Albumen . . .	7·00
White fatty matter . .	4·53
Red fatty matter . .	0·70

Osmazome	1·12
Phosphorus	1·50
Sulphur	5·15

M. Couerbe has detailed the results of his analysis of the brain (*Annales de Chimie*, June 1834), which bears out that of Vauquelin so far as it goes, and adds some other constituents to which he appears to attach consequence in a physiological point of view. He establishes the existence of sulphur, phosphorus, and osmazome, also the two fatty matters; but he gives them scientific names, calling the white matter "cerebrote," the other, from its being pulverulent, "stearconote." He adds to the list an elastic fat (cephalote), and a reddish yellow oil (eleencephol); also cholesterine, and some inorganic salts. In his microscopic examinations of the cerebral mass he found it to be composed of globules, those of the white substance being smaller than the grey, in which particular he differs from other observers.

90. *Nerves, their structure.*—The nerves or nervous cords which issue from the central mass consist of a cylinder of neurine, of a perfectly white colour, enclosed in a thin firm sheath of condensed cellular tissue, called neurilema (νευρον, a nerve; λεμμα, a husk or rind). But the cords thus formed are not simple in their structure, for each may be divided into a number of smaller filaments, possessed of the same component parts as the nerve itself. According to the researches of Prevost and Dumas, one of these minor subdivisions is itself an aggregate of four delicate fibres, placed pair and pair—two external and two internal, the former being more easily recognised than the latter; and, in all, they observe a number of globules placed in regular lines, thus identifying their composition with that of the brain: but this does not accord with the researches of other physiologists. De Blainville denies the existence of regular globules in the nerves, nor does he admit them to contain even the corpuscles or granules which are seen in the central masses.

91. If we take a piece of a nerve two or three inches in length, for instance the median nerve in the arm, we find it white, firm, and cord-like; by rolling it between the fingers it is felt to be made up of several smaller cords; by squeezing it at the cut ends, soft white nervous matter can be forced from each filament. If its ends be pinned to a piece of board, the membrane which encloses all these filaments and gives them the

appearance of a single cord, can readily be dissected off. This is properly the sheath of the nerve. In fig. 28, the sheath is indicated at the upper part, c*, but lower down it is detached and drawn up so as to expose the separate filaments. Now each of these, d*, has its investment, and to this the term "neurilema" should be restricted, as it is in immediate contact with the neurine and constitutes its proper tunic. By dissecting the filaments of a piece of nerve, placed as above indicated, it will be found that they do not lie merely in apposition within their sheath; offsets pass from one to the other, as shown in fig. 27, constituting a plexiform arrangement. But this is not an anastomosis.

When a filament of nerve is examined with the microscope, its surface presents numerous delicate waving lines, as indicated fig. 29. These appear to be in the neurilema, the interior of which will be observed to contain rounded globules (fig. 30), which, however, do not present exactly the same size or form. In a memoir recently published, Ehrenberg establishes a distinction between the filaments which compose the anterior and posterior roots of the spinal nerves. He observed that the posterior or sensitive filaments present slight enlargements from point to point in their course. These he illustrates by numerous drawings.

92. *Cerebral substance—its structure.* The fibrous character of the white substance was distinctly recognised by Malpighi, —the grey he considered to be in its nature glandular. Gall, and all the inquirers of modern date, agree in recognising the fibres of the white substance, and in tracing them in the different directions in which they are disposed: as to the grey matter, Gall viewed it as being the terminus and the origin of the white fibres, its different masses strengthening it and reinforcing it, so as to deserve the name "ganglions de renforcement." Almost all those who have examined the cerebral substance with the microscope, agree in stating it to be composed of globules; but as to their size, form, and composition, many discrepancies exist, which are attributable partly to the intricacy of the subject, partly to the optical errors incidental to such modes of examination. Sir E. Home and Mr. Bauer (*Phil. Trans.* 1821), found the brain to consist of semi-transparent globules, but not of equal size, some being about equal to the nucleus of

blood-globules, others smaller. They recognised, moreover, "a transparent gelatinous substance and a fluid analogous to serum. Upon the relative proportions of these constituents depend the varieties of consistence observed in different portions of nervous matter. Thus, as in the grey substance the gelatinous and serous parts are more abundant and the globules smaller, its consistence is less. In the nerves, though the globules are arranged in lines constituting fibrillæ, they vary much in size." As to the composition of the globules, the Wenzells concluded from their observations (*De penitiori cerebri structurâ*), that they are vesicles filled either with grey or white matter, according to the part examined.

Some other observers state that the globules are largest in the brain, smaller in the spinal marrow, and still less in the nerves (De la Torre); whilst Milne Edwards contends that they are of the same size in all parts of the system.

93. *Ganglia.*—In different parts of the nervous system we find masses or bodies termed ganglia, which vary very much in size and form. Gall, and after him De Blainville, extend the application of the term; for they bring within its meaning the different masses of grey matter in the brain and spinal marrow. If this view be adopted, we shall have to consider as ganglia, 1. The grey masses just alluded to as existing in the spinal marrow, medulla oblongata, optic thalami, corpora striata, corpora rhomboidea,—the conarium, pituitary body, tuber cinereum. The structure of these may be said to be that of the grey cerebral substance, as above noticed. 2. The enlargements which exist upon the posterior roots of the spinal nerves from the fifth cerebral to the last lumbar. 3. Those which are found in the course of the cerebro-spinal nerves, or at the junction of some of their filaments, such as the ganglia of the vagus and glosso-pharyngeal, the submaxillary, spheno-palatine, ophthalmic, otic, petrosal, &c. 4. Those of the trisplanchnic nerves (sympathetic).

94. As to the structure of ganglia, not a few discrepancies exist amongst writers. We cannot be surprised at this when we see that they are very far from being identical objects; and therefore no one statement will rigorously apply to all. The ganglion (Casserian) of the fifth nerve, and all those on the posterior roots of the spinal nerves, seem to have been present to

the mind of those who have described them as closely woven plexuses in which the nervous filaments are divided and suitably arranged before proceeding to their respective points of distribution (Meckel; Zinn). But the ganglia of the trisplanchnic nerves are very different in colour, texture, and composition. They are of a reddish grey colour, well supplied with blood-vessels, possess a smooth investment or capsule, and in their interior we find (if one of them be carefully sliced on a plane with the filaments which enter and emerge) white fibrillæ continuous with the nerves, and supported by grey matter which seems to be analogous to that of the brain. Structures such as these cannot be considered as mere plexuses; the opinion of Winslow, Johnstone, and Bichât, who regarded them as so many distinct nervous centres, appears more tenable. In radiated animals we see the nervous system reduced to a few ganglia connected by filaments and giving some offsets which are sufficient for their simple economy; and in the highest vertebrate animals, before the great nervous centres are developed, and in those acephalous cases in which their growth is altogether interrupted, the vegetative functions have no other nervi-motors than the ganglia and their filaments. It will be asked whether chemical analysis has shown the existence of neurine or cerebrine in the ganglia? There are few, if any, analyses recorded, save that by M. Lassaigne, founded on his examination of the ganglia in the horse. His results were albumen, fatty matter, fibrine, and phosphate of lime. There is no neurine, therefore, notwithstanding the existence of the white filaments continuous with those of the nerve. It is several years since this analysis was made; if it were now repeated, it is very probable that a different result would be obtained.

95. The modes of dividing and arranging the parts of this complex structure, suggested by different writers, appear to have been adopted in the first instance in conformity with the opinions which they entertained of its functions and properties. According to Galen, the brain should be considered as the central or fundamental part; Bartholin assigned that rank to the spinal cord. Most anatomists, in times past, divided the system into two parts, viz. the brain and spinal cord, or the central mass (axis cerebro-spinalis), and the nerves as prolongations from it. Bichât, guided by his peculiar views of the vital phe-

nomena, contended for the existence of two sorts of nervous influence; one being derived from the apparatus appropriated to animal life, viz. the spinal cord, brain, and cerebellum, and the nerves which are connected with them; the other, from the two knotted cords which lie along the spine, which he called the nerves of organic or vegetative life, but which are generally known as the sympathetic or trisplanchnic nerves. Dr. Gall extends the principle of subdivision much farther than his predecessors had done; his previous inquiry into the nature and manifestations of the mental faculties having led him to observe their different modifications in various tribes of animals, as well as in individuals of the same species, and conceiving them to be so many distinct powers, which necessarily require distinct material instruments,—he concluded that each, when in action, works by a distinct portion of cerebral substance, which may be considered as its seat and its organ. In this view of the subject, the nervous system appears to be divisible into as many parts as there are functions to be performed, and faculties to be exercised, each part constituting a special apparatus or organ, as follows:—1. The spinal cord and the double-rooted nerves connected with it, forming the apparatus of sensation and motion; 2. The medulla oblongata and its nerves, being the apparatus of the special senses; 3. The cerebral masses, (cerebrum and cerebellum,) divided into the several organs of instincts, sentiments, moral and intellectual faculties.

96. Willis arranged the nerves under three heads: those arising from the brain, ten in number on each side; those of the spinal cord, thirty-one pairs; and thirdly, the sympathetic nerves. According to this arrangement, nerves differing materially in structure and in function are grouped together, and some which are totally distinct in every particular, are set down as parts of one whole. The seventh pair of nerves, for instance, consists of a hard and a soft part (portio dura, portio mollis); and the eighth consists of three parts, the nervus vagus, glosso-pharyngeal, and spinal accessory. Sœmmering has in some measure lessened the confusion arising from this mode of arrangement, by separating the facial nerve from the auditory, and detaching the glosso-pharyngeal and the accessory from the vagus; but the classification still includes a consideration of their position only, without making any reference to structure or function.

An arrangement of the nervous system, perfectly free from objection, cannot be expected in the present state of our knowledge; for that pre-supposes a perfect acquaintance with its structure and conformation in all classes of animals, from the highest to the lowest,—of its developement, as tending to show the subordination and dependence of its parts,—and of the functions which each of them performs. The division of the nerves into cerebral and spinal cannot be adhered to any longer; for the fifth,[*] so called, cerebral nerve is strikingly contrasted in its structure and function with those around it, and with which it has hitherto been classed, whilst it is in every respect similar to those attached to the spinal cord. Neither ought we to continue, as heretofore, to enumerate the nerves in the order of their position from before backwards along the basis of the brain; for the first cerebral nerve (olfactory) has no similarity in character or in function with the third (motor), nor is the second (optic) more closely allied to the sixth (abductor), or the seventh (auditory) to the ninth (lingual). The nerves of the special senses form a distinct group. The following arrangement of the different parts of the nervous system will suffice for our present purposes, and will be found to conform to the views of the best-informed physiologists:—

- Nervous system of animal life, or life of external relation (Bichât).
  - Cerebro-spinal axis, composed of
    - 1. The spinal cord, with its cranial prolongation (medulla oblongata), which probably should not be restricted to the lower margin of the pons, but be considered as extending up to where the crura cerebri become identified with the hemispheres, thus including the tractus motorius.
    - 2. The cerebral masses (cerebrum and cerebellum).
  - Nerves,[*] or chordæ internunciæ grouped into sets, according to their structure and functions.
    - 1. The spinal nerves, symmetrical, with double roots, a ganglion on the posterior one, thirty-two pairs, including the fifth cerebral nerve.
    - 2. The "respiratory" or "superadded" nerves, attached to the side of the cord (its upper part), and distributed to the respiratory organs, according to the views of Sir Charles Bell.

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[*] Sir C. Bell on the Nervous System.

Nervous system of animal life, or life of external relation (Bichât).	Nerves, or chordæ internunciæ grouped into sets, according to their structure and functions.	3. The simple motor nerves, attached by single roots to the cranial prolongation of the anterior fasciculi of the spinal cord (tractus motorius), 9th, 6th, 3rd. 4. The nerves of special senses, viz. smell, sight, hearing: taste and touch appear to be but modifications of the common tactile property.
Nervous system of organic, or vegetative life; the life of nutrition (Bichât).	The tri-splanchnic nervous system, whose ramifications extend through all the viscera (σπλαγχνα), called by some gangliac (though ganglia are not peculiar to it), also sympathetic. We may, with De Blainville,* consider it as divisible into two parts: one placed in front of the spine (præ-vertebral), composed of plexus and ganglia (semilunar and cardiac), whose branches are distributed to the primary organs of digestion and circulation; the other consisting of two knotted cords, extended along the whole length of the spine, communicating with the præ-vertebral plexuses on the one hand, and with the cerebro-spinal nerves on the other.	

97. It will be observed that the nerves which are connected with the base of the brain, and are thence called cerebral, are here divided into three groups,—those of the special senses, the simple motor nerves, and the respiratory, as they are called, for want of a better name.

The two last M. Arnold (*Icones nervorum capitis*) arranges in a different way. The bones of the head have been long considered the analogues of vertebræ, the foramina at its base are similar to the intervertebral foramina,—if so, they transmit like parts; now, as the nerves which pass out of the intervertebral holes are compound, each having two roots, ministering, one to sensation the other to motion, the several nerves issuing from the base of the skull may be considered as separate fasciculi, some of motor roots, others of sensitive roots. But how many compound nerves are thus formed? That will depend on the number of cranial pieces admitted; and upon this a difference of opinion exists. Meckel, Carus, and Cuvier recognise three, as will be shown in the concluding remarks on the bones of the head. Bojanus admits four, and Geoffroy St. Hilaire raises the number to seven. M. Arnold adopts the former number, and therefore there can be but two intervertebral holes and two compound nerves. In following out such an analogy as this, not a little latitude must be assumed.

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* Cours d'Anatomie et de Physiologie Comparée.

First compound cerebral nerve.	Anterior, or motor root, consists of	The third, fourth, sixth nerves, the smaller or motor division of the fifth, and the seventh (portio dura).
	Posterior, or sensitive root.	The fifth nerve,—its ophthalmic, and superior and inferior maxillary divisions.
Second compound cerebral nerve.	Anterior, or motor root.	The spinal accessory nerve, and the motor linguæ.
	The sensitive, or posterior root.	The glosso-pharyngeal nerve, and the nervus vagus.

I should feel disposed to admit three pairs of compound nerves, and therefore four vertebræ. The first consisting of the third, fourth, and sixth nerves as its motor root, and of the ophthalmic division of the fifth as the sensitive portion: these pass out through the sphenoidal fissure. The second may be said to have for its motor part the anterior or small root of the fifth nerve, and the facial nerve; its sensitive root being composed of the two larger divisions of the fifth nerve. The third compound nerve will then have the spinal accessory and lingual for one root, and the glosso-pharyngeal and vagus for the other.

98. The anatomical constituents, or elements, described in the foregoing pages, are found to enter (variously modified) into the composition of certain parts, each of which is marked by a particular conformation, and intended for a special purpose: these are termed organs. The word *organ* (organon, instrumentum) is used by anatomists to express the material instrument by which an action is executed, or a function performed; for instance, the organ of voice, the organ of respiration. An assemblage of two or more organs, associated in the performance of a common function, is termed *apparatus*, viz. the lachrymal apparatus, the digestive, &c.; and the result which follows a certain action, or is produced by an organ or apparatus, is termed *function*.

99. Descriptive anatomy includes several compartments, which are variously denominated, according to the subjects of which they treat: they are usually arranged in the following order:

OSTEOLOGY (*οστεον, a bone; λογος, discourse,* or *description*) comprises the description of the structure, form, and uses of the osseous system, and its different parts.

SYNDESMOLOGY (*συνδεσμος, a ligament; λογος, a description*), or the description of the ligaments and other structures which serve as the means of connexion between bones, and constitute their articulations, or joints.

MYOLOGY (*μυων, a muscle; λογος, a description*), the description of the muscles, the active agents in the different motions and actions of the body.

ANGEIOLOGY (*αγγειον, a vessel; λογος*), the description of the vessels which convey the circulating fluids.

ADENOLOGY (*αδην, a gland; λογος*), the description of the glands and absorbent vessels.

SPLANCHNOLOGY (*σπλαγχνον, a viscus; λογος*), the description of the viscera situated in the large cavities, and which minister to the more important functions.

NEUROLOGY (*νευρον, a nerve; λογος*), includes the description of the nerves, brain, and organs of sense.

CHAPTER II.

OSTEOLOGY.

100. THE osseous structure is peculiarly fitted, by its solidity and hardness, not only to give support to the soft parts, but also to furnish points of attachment to the muscles, by which the different movements are executed. This solid frame-work of the body is made up of a number of separate pieces, the aggregate of which has been termed "*the skeleton*," (sceletum, *σκελλω, to dry*). The vertebral column may be considered as the central or fundamental part of the whole, both because it exists in all animals which possess an internal osseous skeleton, and also because the different parts of the osseous system are either immediately or mediately connected with it as a common centre. Thus, on its superior extremity or apex it supports the skull; laterally it gives attachment to the ribs, which arch forwards, to form, with the sternum, a bony case for the lodgment of the organs of respiration and circulation, at the same time that they furnish externally points of support for the superior extremities: inferiorly the column is immovably connected with the pelvic bones, which are articulated with those of the lower extremity.

101. When proceeding with the description of the human body, it is usual to consider it as divisible into head, trunk, and extremities, which is sufficient for the purposes of a regional division; but the skeleton must be viewed in a different way, particularly if reference is made to its conformation in the various orders of animals—to its developement—and to the subordination of its component parts. The spine being its essential constituent, all the others (viz. the ribs and sternum, clavicle, scapula, and upper extremities, the pelvic bones and lower extremities,) rank as accessories. The sacrum and coccyx are obviously parts of the spine, so likewise are the cranial bones; for though, in outward appearance, they differ so much in man and the higher animals from the bones of the spine which are placed beneath them, and with which they are articulated, they still are

but modifications of similar organic elements—repetitions, in fact, of like parts differently developed to suit the peculiar relations into which they enter, and the purposes which they are designed to serve.

102. The number of pieces which compose the osseous system varies in the different ages of life; for some, which in the first instance are divided into two or more portions, become soldered together as the process of ossification goes on. But authors are far from being unanimous as to the number of bones which they recognise even in the adult. Do the sesamoid bones form parts of the skeleton, or are they mere accessory structures developed in tendons? Are the teeth, os hyoides, and ossicula auditûs, to be enumerated as components or accessories? Monro and Sœmmering reckon 260 bones; and Meckel, who takes the number at 253, includes the teeth, patellæ, ossa sesamoidea, os hyoides as five pieces, sternum as three, coccyx as four, and the small bones of the ear. If, however, we omit those just named, as being either accessories or connected with special organs, the whole number of pieces found in the ordinary skeleton will be 197, as follow:—

The spinal column, properly so called, consists of 24 vertebræ, the sacrum and the coccyx, (26).

The skull is made up of eight cranial bones, viz. the occipital, two parietal, two temporal, the frontal, the ethmoid and sphenoid:—and of fourteen facial, viz. two nasal, two lachrymal, two superior maxillary, two malar, two palatal, two turbinated, one vomer, and the inferior maxillary bone, (22).

The ribs are 24 in number (twelve on each side), with the sternum, (25).

The two superior extremities consist each of a clavicle and scapula, humerus, radius, and ulna, eight carpal bones, five metacarpal, and fourteen in the digital rows, (64).

The two inferior extremities comprise, each, one pelvic bone (innominatum), one femur, tibia, and fibula, seven tarsal bones, five metatarsal, and fourteen digital, (60).

In the skeleton we recognise two great cavities (which are again variously subdivided); one anterior and inferior, comprising the thorax and abdomen; the other posterior and superior, formed by the union of the vertebral canal with the cranial cavity.

VERTEBRAL COLUMN.

103. The *vertebral column* (columna vertebralis, rachis, spina,) is situated along the median line, at the posterior part of the trunk, the length of which it determines. Anteriorly it presents the form of an irregular pyramid—posteriorly, a series of elongated processes (spinæ), disposed regularly one beneath the other, from which circumstance the term "spine" is derived. Viewed as a whole, it resembles at first sight the shape of a long bone, but it is very differently constructed. As it receives the weight of the head and trunk, and transmits it to the base on which it rests, it requires to be firm and resisting, its power of resistance increasing gradually from above downwards. Being the centre of all the movements of the body, it must be as pliant and flexible as a bow, but yet firm, in order to give adequate protection to the spinal cord which it encloses. All these conditions are attained by its being made up of several small pieces united by an elastic substance, the motion permitted between each pair being slight, while the aggregate of all is considerable.

The *vertebræ*, or separate pieces of which the column is made up, are so named from their mobility (vertere, to turn). They are divided into *true* and *false;* the former term being applied to those which remain separate in the adult, and retain their mobility—the latter to such as become united into one mass, (viz. the sacrum,) or degenerate as it were, and lose all the ordinary characters of vertebræ, (viz. the coccyx). The size of the vertebræ increases from above downwards as far as the first pieces of the sacrum, from which it diminishes towards the end of the coccyx, where it terminates by a point; so that the column may be said to consist of two pyramids applied to one another at their bases. The superior, or movable one, however, does not taper regularly from above downwards in its entire length; it becomes somewhat narrowed and constricted as it were at the third dorsal vertebra, after which it gradually enlarges towards its base.

Vertebræ, division of.—The true vertebræ are divided into three sets, named from the regions which they occupy, *cervical, dorsal, lumbar.* The sacrum and coccyx, which form the remaining part of the column, shall be described with the bones of the pelvis, as they enter into the composition of that cavity, and maintain important relations with the organs which it contains.

The true vertebræ present, 1. certain general characters by which they may at once be distinguished from bones of any other class; 2. those of each region (cervical, dorsal, lumbar,) exhibit peculiar characters by which they are severally distinguished.

104. *General characters of a vertebra.*—It is usual to say that a vertebra consists of body and processes—the body being the primary or fundamental part. The objects presented by each of these bones are, a body, a ring, articulating processes, transverse and spinous processes, and notches: of these, the ring, or foramen, merely to suit the purposes of methodical description, may be considered the central part. As the whole series of vertebræ is intended to form a pillar of support, each, with the exception of the first, presents in front a convex mass (the body), which is a section of a cylinder, and which, by being piled one over the other, form the pillar. As each bone must be securely joined with the one above it and that below it, there exist certain prominences for articulation with them. The column being flexible, and partaking in the several movements of the body, it is required that there be levers for the attachment of the muscles or moving powers. Finally, it is necessary that a free communication should be allowed for the nerves with the nervous centre contained in the canal.

The *ring* (foramen vertebrale, rachidium,) is formed in front by the body, and posteriorly by what is named the *arch* of the vertebra, from which latter the several processes project. As the vertebræ are piled one over the other, the rings are arranged so as to form, with the aid of the interposed ligamentous structures, a flexible canal for the lodgment and protection of the spinal cord.

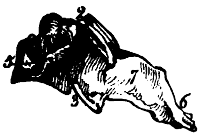
The *body* forms the anterior and most considerable part of the bone. Rounded before, and marked in the middle by a transverse groove, which gives it a constricted appearance, it is slightly hollowed posteriorly, where it contributes to the formation of the vertebral canal, and in most instances is flat on the superior and inferior surfaces, by which, through the medium of a layer of fibro-cartilage, it is connected with the contiguous bones. Its outer surface all round presents numerous foramina for the passage of nutritious vessels. From the body at its lateral margins, two processes pass backwards called "pedicles." The pedicles join with the lamellæ, or plates, and these, by inclining inwards, meet at the median line posteriorly, so as to complete the "arch" of the vertebra. From the point of junction of the pedicles with the lamellæ at each side, the articulating and transverse processes project, and from the union of the two lamellæ the spinous processes take their origin.

Articulating processes.—For maintaining the connexion between the contiguous vertebræ, there are four processes,—two superior, and two inferior,—which project, one on each side, from the junction of the lamella with the pedicle. Two of these processes project upwards, and two downwards; the smooth surfaces of the upper pair look backwards, those of the lower, forwards; they are coated with cartilage, and articulate with corresponding processes of the next vertebræ. Their margins are rough for the attachment of ligaments.

The *transverse* and *spinous* processes form a series of levers for the attachment of muscles. The transverse processes, two in number (one on each side), and named from their direction, project laterally from the arch near the articulating processes, between which their bases are interposed. The *spinous* process is a single projection, situated posteriorly in the median line; this process, or rather the appearance presented by the aggregation of those of the several vertebræ, has given to the entire column one of its designations (spine). The parts of the arch which intervene between the bases of the spinous and the transverse processes are named *laminæ* or *plates*. Lastly, the processes which extend from the lamellæ to the body of the bone, are called "pedicles," as above stated. In each pedicle are seen two excavations, or *notches*, (incisuræ,) one on the upper, the other on the lower border, the latter being deeper than the former. When the vertebræ are placed in their natural position, the notches in the contiguous margins of each pair of them form rounded apertures, which communicate with the vertebral canal, and give transmission to the spinal nerves and to the entering and emerging vessels. From their position and mode of formation they are called the *inter-vertebral foramina* (trous de conjugaison).

These remarks apply generally to all the vertebræ; but as each class presents peculiar characters which distinguish those included within it from others, and as there are peculiarities which mark certain individuals of each class, it becomes necessary to examine them more in detail.

Fig. 32.



105. The *cervical* vertebræ, fig. 32, are seven in number; they are smaller than those in the other regions, which results from the size of the body and processes being less than that of the corresponding parts in the dorsal and lumbar class. The vertebral foramen is of a triangular form, and larger proportionally than in the other classes. The body, fig. 32, 1, elongated transversely, is thicker anteriorly than posteriorly; for the under and forepart of each dips down a little. The upper surface is broader than the under one, and is rendered concave from side to side, by two little plates, which project upwards from its margins. The lower surface is slightly convex, and rounded off at the sides. The superior articular processes, 2, are flat and oblique in their direction, so as to look backwards and upwards, whilst the inferior, 3, incline downwards and forwards. The transverse processes, 4, short, and bifid at their extremities, present a groove, 5, superiorly for the transmission of the nerves, and at their base a foramen, through which in most of them the vertebral artery passes. It will be observed, that these processes have two roots or points of connexion with the vertebra. The posterior one springs from the junction of the pedicle with the arch, and therein corresponds with the transverse processes in the back and loins. The anterior one is attached to the side of the body of the vertebra, and ranges with the ribs, of which it is a rudiment. The formation of the foramen can, from these facts, be readily indicated. The osseous points, which here represent the ribs, not being required for any special purpose, remain in their rudimentary condition, and merely incline backwards, so as to become anchylosed with the true transverse processes which lie behind them. They thus enclose a space, viz. the foramen, which, however, cannot be

said to be intended to lodge the vertebral vessels, as it exists in the seventh cervical vertebra, through which they do not pass, and in the sixth and fifth in those cases in which the artery enters at the fourth. The spinous process, 6, is short, projects horizontally backwards, and is bifid at its extremity. The plates, 7, are narrower and longer than in the other regions. The notches are deeper and larger in the upper than in the lower border of the pedicles, in all except the second. They lie behind the articular processes in the first, but before them in the rest.

106. The *dorsal* vertebræ, fig. 33, twelve in number, are intermediate in size, as well as in situation, between the cervical and the lumbar. The foramen is smaller than in the cervical or lumbar region, and is nearly circular in its form. The lateral notches, 1, 2, and consequently the inter-vertebral foramina which they form, are larger than those in the neck; and those at the lower margin of the pedicles are much larger and deeper than those on the upper. The depth of the body, 3, taken from before backwards, is greater than its breadth from side to side; it is convex and prominent on the anterior surface, flat and plain at the upper and lower; at each side of the body may be observed a slight notch, 4, 4, in the superior as well as in the inferior border,—these, when the vertebra is placed in apposition with the adjacent ones, form oval depressions for the reception of the heads of the corresponding ribs. The articulating processes, 5, 6, are nearly vertical in their direction; the superior looking backwards, the inferior forwards. The transverse processes, 7, are long and inclined backwards, and on the anterior surface of each of their tubercular terminations is situated a slight excavation, 8, which in the fresh state is tipped with cartilage, and articulates with the tubercle of the rib. The spinous processes, 9, elongated and triangular, are directed downwards, and terminate in a tubercle, 10. The plates are broad and thick, but shorter than those in the neck.

Fig. 33.

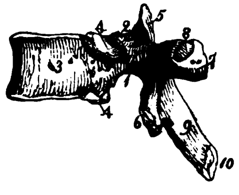
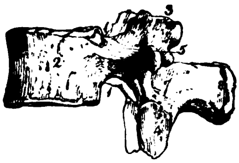


Fig. 34.

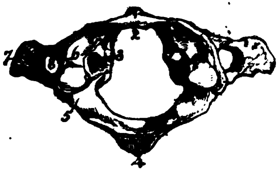


107. The *lumbar* vertebræ, fig. 34, five in number, are larger than either of the other sets. The foramen of each vertebra in this region is large and triangular. The notches, 1, 1, for the formation of the inter-vertebral foramina are very deep, especially the inferior pair. The body, 2, broader from side to side than from before backwards, is flat on its superior and inferior surfaces. It is not so convex anteriorly as that of the dorsal vertebræ. The articulating processes are thick, strong, and disposed vertically; the superior pair, 3, concave, look inwards and backwards; the inferior, 4, convex, outwards and forwards; the former are farther apart than the latter, hence they receive and in a manner embrace the lower articulating processes of the vertebra above them. The transverse processes, 5, long, thin, and horizontal, do not project backwards like those of the dorsal vertebræ. The spinous process is broad, flat, and nearly of a square form, so that it terminates not by a pointed extremity, like those in the dorsal region, but presents rather a compressed and rough border, 8. The plates, 7, though shorter, are deeper and thicker than those of the dorsal vertebræ.

108. The general characters of vertebræ, and the differences which characterise those of different regions, being considered, it remains to point out certain peculiarities presented by some individual bones in each set. It may be here stated generally, that the vertebræ situated at the extremities of each region assimilate in some degree to the characters of those in whose vicinity they are placed. Thus, for instance, the lower pieces of the cervical region begin to resemble the dorsal vertebræ, and the latter become, by a similar transition, assimilated to the lumbar,—the characters peculiar to each region being best displayed by the bones situated towards its middle point.

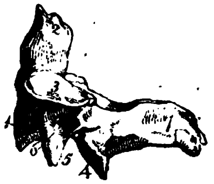
Peculiarities of certain vertebræ.—The first, second, and seventh cervical vertebræ present some characters which distinguish them from the others.

Fig. 35.



The first, or *atlas*, fig. 35, (so called from supporting the head,) is an irregular ring of bone, which presents nothing analogous either to the bodies or spines of the other vertebræ. The ring, in the fresh state, is divided into two parts by a transverse ligament,—the anterior one being occupied by the odontoid process of the axis, the posterior by the spinal cord,—it presents in front a small arch of bone, the anterior surface of which is marked by a tubercle, 1, the posterior by a smooth depression, 2, adapted to the odontoid process of the axis. The posterior segment of the ring is considerably larger than the anterior; at its middle point it presents a tubercle, 4, which is the analogue of the spinous processes; it is thick and round in the greater part of its extent; but at its junction with the rest of the vertebra there exists on the upper border at each side a smooth groove, 5, which lies behind the superior articular process, and marks the tortuous course pursued by the vertebral artery previously to entering the cranium. This groove is analogous to the notches in the other vertebræ, for it transmits the first spinal nerve as well as the vertebral artery; it is sometimes converted into a foramen by a spicula of bone. The articulating surfaces are horizontal and large; the superior pair, 6, receive the condyles of the occipital bone; they converge in some sort towards the forepart of the bone; and as their form is oval, and their surface concave from before backwards, they look towards one another; at the inner margin of each is a rough surface, 3, which gives attachment to the transverse ligament. The inferior pair, on the contrary, are flat, and nearly circular in their form. The parts of the vertebra (*lateral masses*) on which these processes are situated are of very considerable thickness, because the weight of the head, which in others is received by the bodies, rests here on the articular surfaces. The transverse processes, 7, project considerably on each side, and terminate in a rounded point; at the root of each is situated the foramen, 8, which transmits the vertebral artery.

Fig. 36.



The second vertebra, fig. 36, or *axis*, (so called from forming the pivot on which the head rotates,) is somewhat triangular in its form. The body, 1, presents anteriorly a vertical ridge, bounded on each side by a depression for the attachment of the longus colli muscle; superiorly it is surmounted by a process, 2, (*odontoid*, *p. dentatus;* whence is derived the name *vertebra dentata*,) presenting two smooth surfaces, one for its articulation with the atlas, the other with the transverse ligament which retains it in its situation; being constricted inferiorly, and somewhat enlarged towards the summit, these parts of the process are called respectively its *neck* and *head*. The superior articulating processes, 3, are of considerable size, and nearly horizontal; they are close to the body, so as to communicate to it the weight of the head, transmitted to them by the articular processes of the atlas; the inferior pair, 4, are oblique, and of the same size as in the vertebræ beneath them. The transverse processes, 5, are neither grooved nor bifurcated, and the foramen at their root, 6, is inclined obliquely outwards. The spinous process, 7, is very large, and gives attachment to several muscles; it is deeply grooved on its inferior surface; the plates which support it are of proportionate size.

The *seventh*, or prominent vertebra, approaches in its characters to those of the dorsal region; its spinous process terminates in a tubercle, and is so long as to be, in the natural condition, felt underneath the skin; whilst the other cervical spines lie more deeply, and are covered by muscles; hence the term "prominent," so commonly applied to this vertebra. The transverse process, though pierced by a foramen, presents but a slight appearance of a groove on its upper surface, and seldom more than a trace of a bifurcation at its extremity.

The *first dorsal* vertebra is marked at each side by a complete articular surface for the first rib, and on its inferior border by a slight excavation, which receives half the head of the second: the upper articular processes are oblique, and the spinous more nearly horizontal than those below it.

The *tenth* dorsal vertebra is usually marked by an articular surface, which receives the entire of the head of the corresponding rib.

The *eleventh* is distinguished by its transverse processes not presenting an articulating surface for the tubercle of the rib, whilst the form of its spinous process, of its lamellæ and body, approaches that of the lumbar vertebræ.

The *twelfth* dorsal vertebra resembles the eleventh in most of its characters; but its transverse processes are shorter, and the lower articular pair convex and directed outwards, so that its conformation resembles that of the lumbar vertebræ in these particulars.

Amongst the *lumbar* vertebræ, the fifth only is distinguishable by any peculiarity deserving of notice, its body being thicker anteriorly than posteriorly, and its transverse process short, thick, and rounded.

109. The bones just described, when ranged in their natural position, form a pyramid, the length of which is equal to about two feet two or three inches; taken as a whole it presents an anterior and posterior surface, two lateral surfaces, a base, and a summit, each deserving a particular notice.

110. The anterior surface is broad in the cervical, narrow in the dorsal, and again expanded in the lumbar region; it is marked by a series of transverse grooves corresponding with the centre of the bodies of the vertebræ, and in the fresh state is covered by the anterior common ligament. When viewed in profile, it presents three curves depending on the different degrees of thickness of the anterior and posterior part of the bodies of the vertebræ in the different regions, but still more on that of the inter-vertebral substance. In the neck and loins the convexity of the curve is forwards, in the back it is in the opposite direction. A slight degree of lateral curvature is also observable in most cases in the dorsal region, the convexity of which is directed towards the right side. The older anatomists imagined this to be produced by the action of the aorta beating against the left side of the column; but Bichât attributed it to the effect of muscular action, and explained it in the following way:—As most persons are disposed to use the right arm in preference to the left, the muscles of that side become stronger, and act with more power on the points to which they are at-

tached; when making efforts, as in pulling, the body is curved to the left, which gives an additional advantage to the muscles; and the habitual use of this position gives rise to some degree of permanent curvature. In support of this explanation of the fact, Béclard has stated that he found in one or two individuals, who were known to have been left-handed, the convexity of the lateral curve directed to the left side.

111. The posterior surface presents along the median line the spinous processes, varying in form and direction, as has been already stated, being horizontal in the cervical and lumbar regions, and nearly vertical in the dorsal. Those in the cervical and dorsal regions correspond pretty exactly with the middle line, but in the back the spines will be observed in many instances to incline, some to one side, some to the other. On each side of these are the vertebral grooves, extending from the base of the skull to the sacrum; their breadth corresponds with that of the laminæ; they are broad but shallow in the neck, and become deep and narrow lower down. Along the grooves are seen the spaces between the laminæ, which in the natural condition are filled up by the yellow ligaments. The breadth of these intervals is very trifling in the neck and in the greater part of the back; it increases in the lower third of the dorsal, and still more in the lumbar region. The interval between the occipital bone and the atlas is considerable, and so is that between the last lumbar vertebra and the sacrum.

The lateral surfaces of the column present the transverse processes, varying in form and character in the different regions; before these are situated the inter-vertebral foramina, and more anteriorly still, in the dorsal region, the articulating surfaces which receive the heads of the ribs.

The summit is articulated with the occipital bone, and supports the head, whilst the base, or broader extremity, rests on the sacrum. Along the entire extent of the column runs the vertebral canal, which is broad and triangular in the cervical and lumbar regions, circular and contracted in the dorsal. The canal may be said to expand at its upper extremity into the cranial cavity, and at its lower end to be prolonged into that of the sacrum.

112. *Developement.*—In the description here given of the vertebræ, each of them is considered as a single bone; and so it

is when fully formed. But in the fœtal state and in early infancy each consists of at least three pieces, representing so many centres of ossification, one corresponding with the body and one for each lateral mass. The spinous process has even been observed to commence by a separate point, and analogy would lead to the inference, that the anterior and posterior segments of the body are produced from distinct centres. Are we to go farther still, and admit that the body in the first instance consists of two lateral halves? If so, instead of three, we should have eight incipient osseous points in each of these bones. The atlas has three osseous nodules from which its ring is completed, one at each side for the lateral masses, and one in front for the anterior arch. Bichât found in some cases two additional points in the posterior arch. The second vertebra commences by five points at least, two of them being in its odontoid process.

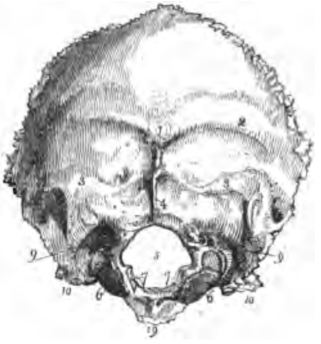
OF THE SKULL.

113. The skull is of a spheroidal figure, compressed on the sides, broader behind than before, and supported by its base on the vertebral column. It is divided by anatomists into two parts, the cranium and the face; the former being composed of eight bones, viz. the *occipital*, *two parietal*, the *frontal*, two *temporal*, the *sphenoid*, and the *ethmoid;* the latter is made up of fourteen bones, viz. two *superior maxillary*, two *malar*, two *ossa nasi*, two *ossa palati*, two *ossa unguis*, two *inferior turbinated* bones, the *vomer*, and *inferior maxilla ;* the frontal bone is so situated as to be common to the cranium and face. The bones of the ear are not included in this enumeration, as they belong rather to a special organ than to the skeleton considered as the frame-work of the body.

THE OCCIPITAL BONE.

114. The occipital bone, fig. 37, (os occipitis,) is situated at the posterior part of the base of the skull; broad behind, narrowed to a point before, of a trapezoid figure, presenting two surfaces, four borders, and four angles. To place the bone in its natural position, hold it so that the great foramen and the articulating processes beside it shall look directly downwards; the thick process in front of the foramen will then project forwards into the base of the skull, whilst the broad expanded

Fig. 37.

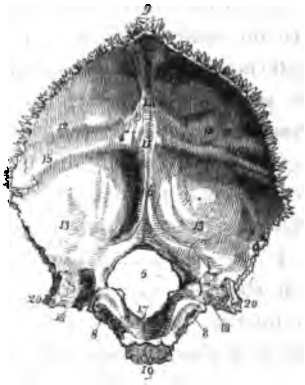


part behind it, arches upwards and a little forwards, forming the posterior wall of the cavity. *External surface:* this is convex in its general outline, and presents a little above its centre a rough prominence, 1, the *occipital protuberance*, the part between which and the superior angle is smooth. Extending obliquely outwards at each side from the protuberance is a rough line, 2, called the *superior curved line*, to distinguish it from another which is lower down between it and the great foramen, called the *inferior curved line*, 3; both are prominent, and give attachment to muscles, as also do the rough depressions between them. These are crossed by a vertical line, 4, extending forwards from the protuberance to the foramen.

The *occipital foramen*, 5, (foramen magnum,) which is of an oval figure (its long diameter extending from before backwards), gives transmission to the spinal cord, the vertebral arteries, and spinal accessory nerves.

At each side of the foramen, but nearer its anterior part, are situated the articulating processes, 6, 6, (*condyles*,) two oblong eminences, which articulate with the first vertebra. These converge from behind forwards; their inferior surface, which in the fresh state is smooth, covered with cartilage, and convex in its general outline, looks downwards and outwards, and is adapted for moving on the concave surface presented by the articulating processes of the atlas. The inner border of each condyle, 7, 7, is rough, and receives the insertion of the check ligaments, which extend up from the odontoid process of the axis; the outer border, depressed and not so well marked, gives attachment to the ligament connecting it with the atlas.

External to the forepart of the condyles are two fossæ, in the bottom of which are two foramina, fig. 38, 8, 8, (*anterior condyloid*,) which look outwards and forwards, and transmit the hypoglossal nerves; behind them are also two larger pits, in which are generally, but not always, found foramina, Fig. 37*.



9, 9, (*posterior condyloid,*) which give passage to a vein and small artery: sometimes a foramen exists at one side, and not at the other. External to each condyle is a rough surface, 10, 10, which overhangs the transverse processes of the vertebræ, and of which it may be regarded as the "analogue;" it gives insertion to the rectus lateralis muscle.

115. The *internal surface* of the bone (fig. 37*), is marked by two lines—one vertical, extending from the upper angle of the bone to the great foramen, and the other transverse from one lateral angle to the other. These intersect towards the central point, 11, (internal occipital protuberance,) and mark off four pits, of which the upper pair, 12, 12, (superior occipital fossæ,) receive the posterior lobes of the brain, and the lower, 13, 13, (inferior occipital fossæ,) lodge the lateral lobes of the cerebellum: the superior line, 14, and the two transverse ones, 15, 15, are generally grooved, and correspond with the course of the longitudinal and lateral sinuses. The inferior one, 16, gives attachment to the falx cerebelli. The anterior border, 17, of the foramen magnum is slightly excavated, and becomes continuous with the *basilar groove*, a shallow excavation on the surface of the basilar process, which supports the medulla oblongata; close to the margin of the foramen are the anterior condyloid foramina, and a little external to it are two fossæ, 18, 18, marking the terminations of the lateral sinuses.

The thick triangular process, 19, which projects forwards into the base of the skull from the foramen, is called the *basilar* process; its margins are rough, and contiguous to the pars petrosa of the temporal bone; its under surface presents slight depressions for the insertion of muscles, and the upper one the shallow groove just noticed.

The *superior borders* of the occipital bone are dentated and converge to a point, 9, but are frequently interrupted by bony islets (ossa triquetra—Wormiana); the inferior border at each side is divided into two parts by a prominent piece of bone, 20, 20, the *jugal eminence*, which surmounts an excavation contributing with the temporal bone to form the jugular fossa. The superior angle is acute, and received into the retiring angle formed by the posterior border of the parietal bones; the anterior is represented by the extremity of the basilar process; the lateral angles, not very prominent, correspond with the line at which the postero-inferior angle of the parietal bone joins with the mastoid part of the temporal.

Articulations.—The occipital articulates with six bones, viz. with the two parietal by its superior borders—the two temporal by the inferior—with the sphenoid by its basilar process—and with the atlas by the condyles.

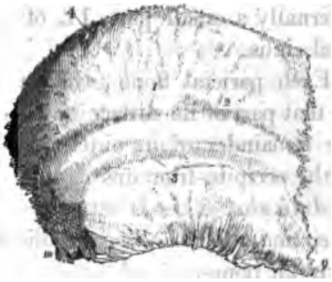
Attachments of muscles.—The posterior third of the superior curved line gives attachment to the trapezius; its anterior two-thirds to the occipito-frontalis above, and to the sterno-mastoid below: the inner part of the space between the curved lines to the complexus: the external part to the splenius capitis: the space between the lower ridge and the great foramen to the recti majores and minores, and more outwardly to the obliquus superior: the under surface of the jugal eminences to the recti laterales: the fossæ at the inferior surface of the basilar process to the recti antici (majores and minores), and still more anteriorly to the superior constrictor of the pharynx.

Developement.—In the fœtus at birth this bone consists of four distinct pieces, of which one represents the basilar process, two the lateral or condyloid portions, and one the posterior or expanded part. Hence it is usually said to commence by four points of ossification. Meckel, however, is of opinion that it has no fewer than eleven separate centres, eight of them being in the broad (squamous) part. This doubtless has existed in some specimens which he examined; but ordinarily in the early stages of the developement there are found two ossific points in the lateral parts as above stated, one in the anterior or basilar, and four in the posterior broad part.

THE PARIETAL BONE.

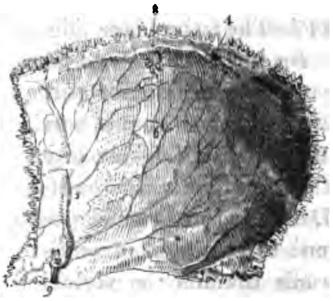
116. The parietal bones (ossa parietalia) form a principal part of the roof of the skull; they are of a square form, convex externally, concave internally, and present each two sur-

Fig. 38.



faces and four borders. The external surface, fig. 39, rises towards its middle, where it presents a slight elevation, called the *parietal eminence*, 1, below which is a curved line, 2, 2, forming part of the temporal ridge, and bounding a flat surface, 3, which forms a part of the temporal fossa. At the upper and back part of the bone, usually about two lines from the sagittal suture, is a small hole, 4, (foramen parietale,) which transmits a communicating vein; its position is exceedingly variable; even its existence is not constant.

Fig. 38*.



The internal surface of the bone, fig. 38*, is marked by branching lines, 5, 5, 5, corresponding with the course of the middle meningeal artery, and by depressions for the convolutions of the brain. Towards its middle is a depression, 6, "parietal fossa," corresponding with the eminence (parietal) on the outside. Along the superior border is a slight depression, 7, 7, which with a similar one in the corresponding bone forms a groove adapted to the course of the longitudinal sinus; and in the same situation (in most skulls, particularly those of old persons) are some small pits, 8, corresponding with the so-named glandulæ Pacchioni.

The superior border is straight, and articulated with its fellow by a series of dentations; the inferior border, concave and bevelled off at its outer margin, is overlapped by the squamous portion of the temporal bone; the anterior unites with the frontal bone, and the posterior with the occipital.

The anterior inferior angle, 9, dips down to the great wing of the sphenoid bone, and presents a groove, 9, internally for the middle meningeal artery: the posterior inferior angle, 10, articulates with the mastoid part of the temporal bone, and presents internally a small part, 11, of the groove which lodges the lateral sinus.

Each parietal bone gives attachment to the temporal muscle by that part of its surface which lies beneath the temporal ridge: the remainder of its outer surface is covered by the aponeurosis of the occipito-frontalis.

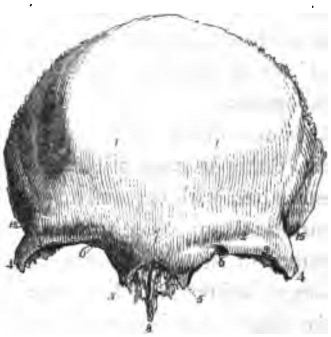
Articulations.—It articulates with its fellow of the opposite side, and with the frontal, the sphenoid, the temporal, and the occipital bones.

Developement.—Its growth proceeds from one ossific centre which corresponds with the parietal eminence. At birth the antero-superior angles of these bones are not developed; hence there exists an interstice between them and the still divided os frontis, which is called the "fontanelle" (fons, bregma).

THE FRONTAL BONE.

117. The frontal bone, fig. 39, (os frontis, coronale,) situated at the anterior part of the skull, and upper part of the face, is divisible into two parts (frontal and orbital), differing in size and position; of these, one extends upwards towards the vertex, forming three-fourths of the extent of the bone; the other, inferior and horizontal in its direction, forms the roof of the orbits. To place the bone in its natural position, hold it so that the orbital plates shall look downwards, and the smooth convex surface forwards.

Fig. 39.

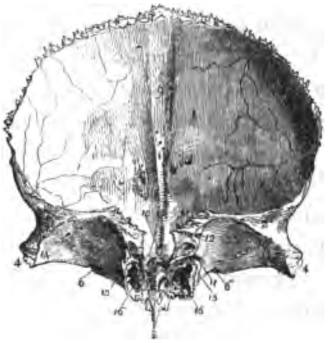


The external surface of the frontal part is smooth, and presents on each side a slight elevation, 1, 1, named *frontal eminence*, which corresponds with the most prominent part of the forehead: beneath this is an arched depression, bounded below by a prominent curved line, 2, 2, called the *superciliary ridge*, or arch, which is more or less prominent in different individuals. Immediately beneath this is the margin of the orbit (*orbital arch*), 3, 3, which is better defined towards its outer part, where it curves down to the malar bone, and forms the external angular process, 4, 4, than at its inner portion, 5, 5, where it gradually subsides towards the root of the nose. Towards the inner third of the orbital arch is a small foramen, 6, 6, (*supra-orbital*,) or sometimes a notch, crossed by a ligament, which transmits the supra-orbital nerve and artery.

Between the superciliary ridges is the *nasal eminence*, 7, or glabella, which is prominent in proportion to the size of the frontal sinuses; it is bounded inferiorly by a rough surface which articulates with the nasal bones and the ascending processes of the superior maxilla. From this surface projects downwards in the median line a flat thin process, 8, called the *nasal spine;* it articulates in front with the nasal bones, and behind with the perpendicular lamella of the ethmoid.

The internal surface of this part of the bone is concave, and presents along the median line a groove, fig. 39*, 9, corresponding with the longitudinal sinus. The margins of the groove gradually approach towards the forepart of the bone, and in some cases unite so as to form a ridge; but in others the groove, narrowed almost to a line, continues apparent down to the foramen cæcum. In either case it gives attachment to the falx; this ridge terminates in a minute foramen, 10, called *foramen cæcum*, from its having been supposed to be merely a cul-de-sac, but it is in reality pervious, and lodges a small spur-like process of the dura mater, and transmits a vein which enters the sinus from the nasal fossæ.

Fig. 39*.



118. The orbital plates or processes are smooth and concave at their inferior surface, the superior or cerebral is convex, and marked more or less in different instances by elevations and depressions corresponding with the sulci and convolutions of the

anterior lobes of the brain which rest upon them. They are separated by a deep excavation (incisura ethmoidalis), which receives within it the cribriform plate of the ethmoid bone, and round its margins are several cells which complete the cavities lodged within the lateral parts of the last-named bone. In this margin may also be observed two foramina, 11, 12, (*anterior* and *posterior orbital*,) which are common to the frontal and ethmoid bones, as their contiguous margins contribute to their formation. The anterior one transmits the nasal twig of the ophthalmic nerve, and the anterior ethmoidal artery; the other the posterior ethmoidal artery and vein. Each orbital plate is bounded externally by a thick well-marked prominence, 4, 4, called the *external angular process;* and internally by a depressed and smooth one (*internal angular process*). Near the inner one is a slight depression, 13, to which is attached the cartilaginous pulley of the trochlearis muscle; near the outer and within the orbit, is a depression, 14, for the lodgment of the lachrymal gland; the external side of this process is slightly hollowed, fig. 39, 15, and forms part of the temporal fossa.

The thickness of the frontal bone varies considerably in different parts of it. The orbital plates are thin and translucent; the nasal and external angular processes are thick and prominent. The upper or broad part is thinner at the frontal eminences than elsewhere, if these are well-marked so as to indicate a full developement of the corresponding cerebral parts. In childhood the two tables are separated only by the diploë, as in other bones; but, in adult age, an interval exists between them at the middle line over the nasal process, and extending outwards for some way under the superciliary ridges. This interval, the extent of which varies in different individuals, is divided by a ridge of bone into two parts or cavities, 16, 16, called the *frontal sinuses;* they are lined by mucous membrane, and communicate with the anterior ethmoidal cells.

Articulations.—The frontal articulates with twelve bones; superiorly with the two parietal, laterally and behind with the sphenoid, inferiorly with the ethmoid; with the nasal bones by the nasal spine; with the ossa unguis; with the ascending process of the superior maxillary bones; and with the malar bones. The mode of articulation differs in different parts of its circumference. Thus, the superior border is found to overlap and rest on the parietal bones, whilst towards the lateral and inferior parts the exterior table of the bone is bevelled off, and is covered in by the parietal. The posterior border of the orbital plates, straight and squamous, is in a manner inserted between the margins of the two alæ of the sphenoid bone, with each of which it articulates.

Attachment of muscles.—It gives attachment to the corrugator supercilii—to a small part of the temporal and of the orbicularis palpebrarum.

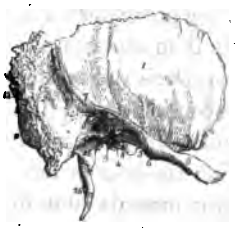
Developement.—This bone begins by two osseous points corresponding with the frontal eminences. The lateral pieces formed by the spreading of the ossification ultimately become united along the middle by a straight suture, which runs from the vertex, where it is continuous with the sagittal suture down to the nose. It is generally obliterated at an early period.

THE TEMPORAL BONE.

119. The temporal bones, two in number, are so named because they occupy that part of the head on which the hair first becomes white, and thus indicates the ravages of time (*ossa temporis*).

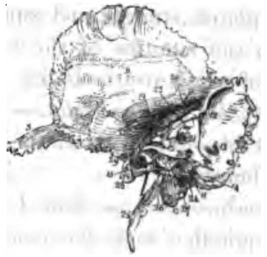
The *temporal* bone, fig. 40, (os temporis,) is placed at the side and basis of the skull. When viewed in its natural position, it presents two portions, one at the side of the skull towards its middle and lower part, which is flat and vertical in its direction; whilst the other is horizontal and projects inwards so as to be wedged between the occipital and sphenoid bones. But to facilitate its description, it may be divided into three parts, adopting the division which obtains in infancy before the ossification is complete. One is superior, flat, scale-like, and named the squamous portion (squama, a scale); another posterior, thick at its base, but tapering downward like a nipple, the mastoid part; the third, called petrous from its hardness, is internal and intermediate, projecting into the basis of the skull.

Fig. 40.



The *squamous* portion, 1, (pars squamosa,) by its external surface which is smooth, forms part of the temporal fossa, and is bounded above by an arched border, below by a horizontal process called "zygoma." The inner surface, fig. 41, 2, of the squamous part of the bone, slightly concave in its general outline, is marked by cerebral impressions like the other bones of the head, and by slight linear grooves for the branches of the middle meningeal artery. Its upper edge is bevelled off so as to form a thin scale which overlays the parietal bone.

Fig. 41.



The *zygoma*, 3, or zygomatic process (ζευγνυμι, to connect or yoke together), forms a yoke connecting the temporal with the malar bone, and under which the temporal muscle passes; it is broad posteriorly at its base, where it projects outward from the squamous part of the bone, but soon narrows, and turns forward; its outer surface is convex and subcutaneous, the inner surface is concave and bounds the temporal fossa; the superior margin, very thin, gives attachment to the temporal fascia; the inferior one is thicker and shorter, owing to the end of the process being bevelled off so as to rest on the malar bone, with which it articulates. At its base the upper surface is concave and supports the posterior border of the temporal muscle. The under surface forms the border of the glenoid cavity; here it presents two roots, of which one, 4, runs horizontally backwards, forming the outer margin of the glenoid cavity, whilst the other, 5, turns inwards and forms the anterior border of that cavity. At the point of division is a slight tubercle, 6, which gives attachment to the external lateral ligament of the lower jaw. Now the anterior root widens and subsides, becoming concave from without inwards and convex from before backwards, as it forms part of the articular surface upon which the lower jawbone moves; in its natural condition it is covered with cartilage. The other root, which is continued horizontally backwards, bifurcates, one part, 8, turning inwards to the fissura Glasseri, whilst the other, 7, gradually subsides as it passes backwards over the auditory tube, yet marks the separation between the squamous and mastoid portions of the bone. The *glenoid fossa* (γλήνη, a shallow pit), marked off as here indicated, is elongated from without inwards, and divided into two parts by a fissure, 9, (*fissura Glasseri*,) which transmits the chorda tympani nerve, laxator tympani muscle, and gives attachment to the processus gracilis of the malleus. The part before the fissure is smooth, and articulates with the lower jaw; the remainder lodges a process of the parotid gland.

The *mastoid* part, 10, of the bone externally is rough, for the attachment of muscles, and prolonged downwards, forming the mastoid, or nipple-shaped process (μαστος, a nipple; ειδος) from which this division of the bone is named. This process overhangs a groove, fig. 41, 11, (*digastric fossa*,) for the attachment of the digastricus muscle; close to this is a slight groove, 14, the occipital groove. When viewed at its inner surface, the mastoid part presents a broad and generally a deep groove, 12, which curves forwards and downwards; it here supports part of the lateral sinus. It is usually pierced by a foramen, 13, (mastoideum,) which opens into the sinus from the outer surface, commencing near the posterior border of the bone. The size and position of this hole vary in different instances; it sometimes exists at one side and not at the other.

120. The *petrous* part, 15, pars petrosa, (πετρος, a stone,) forms a triangular pyramid (pyramis trigona) which projects into the base of the skull forwards and inwards; it presents a base, an apex (truncated), three surfaces, and three borders. In the base is situated the orifice of the auditory canal, which is bounded above by the posterior root of the zygoma; inferiorly, and in the greatest part of its circumference, by a curved uneven lamella (*auditory process*), to which the cartilage of the ear is attached: this process is in the fœtus a separate piece. The canal itself (*meatus auditorius externus*), narrower in the middle than at its extremities, is directed obliquely forwards and inwards, and leads into the tympanum. The apex or inner end of the pars petrosa, rough, irregular, and, as it were, truncated, forms part of the foramen lacerum medium, and is pierced by the termination of the carotid canal, 18, (canalis caroticus):—this canal commences in the inferior surface of the bone anterior and internal to the jugular fossa, ascends at first perpendicularly, but soon turns horizontally forwards and inwards to the apex, where it ends.

121. The anterior surface, 19, of the petrous portion forms part of the middle fossa in the base of the skull, where it looks obliquely upwards and forwards. Towards the apex it is slightly grooved, 20, where it corresponds with the ganglion of the fifth pair of nerves (Casserian). A narrow groove is seen to run obliquely backwards and outwards; it lodges a small nerve (the Vidian); it is named the *hiatus Fallopii*, and leads to the aqueduct of Fallopius. Farther back is a rounded eminence indicating the situation of the superior semi-circular canal. The *aqueduct* of Fallopius just alluded to commences at the internal auditory meatus; it is a small osseous tube lodged in the interior of the bone, and passing at first in an arched direction, outwards and upwards, then backwards and downwards towards the basis of the skull, where it ends in the stylo-mastoid foramen; it transmits the portio dura, and receives, through the hiatus Fallopii, the Vidian nerve. The posterior surface looks obliquely backwards, and forms part of the third or posterior fossa at the base of the skull. In it will be observed a large orifice, 21, leading to a short canal (*meatus auditorius internus*). The canal is oblique in its direction, having an inclination outwards and forwards. It conveys the auditory and facial nerves. Its fundus is formed by a lamella of bone (*lamina cribrosa*), divided into two parts by a crest or ridge; the upper or smaller part is pierced by a foramen which transmits the facial nerve, whilst the lower presents several very small apertures through which the fibrillæ of the auditory nerve pass. About three lines further back than the orifice of the meatus is a narrow fissure, 22, oblique in its direction. It is the termination of the aquæductus vestibuli. Between the aperture of the aqueduct and that of the meatus is an irregular depression, into which a small process of the dura mater is fixed.

On the inferior surface of the pars petrosa, which is exceedingly irregular, we observe, proceeding from within outwards and backwards, a rough surface, 23, giving attachment to the levator palati and tensor tympani muscles, the carotid foramen, the jugular fossa, the vaginal and styloid processes; lastly, the stylo-mastoid foramen. The carotid foramen leads into the curved canal (canalis caroticus) already noticed. The *jugular fossa*, 24, (fossa bulbi venæ jugularis internæ,) is named by some the "thimble-like" cavity, also the "foramen lacerum posterius." It is of large size, and formed in the contiguous margins of the temporal and occipital bones. It is in some cases divided into two parts, but unequally, by a spicula of bone; the anterior and inner portion gives passage to the glosso-pharyngeal, vagus, and spinal accessory nerves, whilst the posterior and larger one transmits the jugular vein. External to the margin of the fossa is the styloid or pencil-like process, 25, long and tapering, with an inclination downwards and forwards. Its length varies from an inch to an inch and a half; it gives attachments to three muscles and two ligaments. Close before the base of the styloid process is a compressed bony plate, 26, the free surface of which looks obliquely forwards and forms the back part of the glenoïd or articular cavity. This is named the *vaginal* process (vagina processûs styloidei). Between the root of the styloid process and the mastoid is the *stylo-mastoid foramen*, 27, (f. stylo-mastoideum,) so called from its position with regard to the processes just named. It forms the outlet or termination of the aqueduct of Fallopius, and gives exit to the facial nerve.

The superior border of the pars petrosa is grooved for the petrosal sinus, 28; the anterior, which is very short, forms, with the squamous part, an angle at their point of junction, in which is situated the orifice of the Eustachian tube, 29, a canal which leads from the pharynx to the tympanum: above this, and separated from it by a thin horizontal lamella (*processus cochleariformis*), is another osseous tube, that gives passage to the tensor tympani muscle. The posterior border articulates with the basilar process of the occipital bone and forms with it the jugular fossa. About the middle of this edge or border is a minute foramen, 30, the opening of a small canal leading from the cochlea (*aquæductus cochleæ*).

Articulations. — The temporal bone articulates with the parietal, malar, inferior maxillary, sphenoid, and occipital bones.

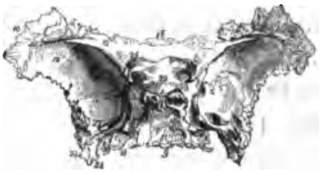
Attachments of muscles.—To the zygoma is attached the masseter; to the squamous portion, the temporal; to the mastoid process, the retrahens aurem, the sterno-mastoid, splenius capitis, and trachelo-mastoideus; to the digastric fossa, the digastricus; to the styloid process, the stylo-glossus, stylo-hyoideus, and stylo-pharyngeus; to the apex of the petrous portion, the levator palati and tensor tympani.

Developement.—The squamous, mastoid, and petrous parts of the bone have each a separate ossific centre. So have the processes, viz. the zygomatic, styloid, and auditory.

THE SPHENOID BONE.

122. The sphenoid is a single bone, figs. 42, 43, placed transversely at the base of the skull, and articulated with all the bones of the cranium and several of those of the face, between which it is inserted somewhat like a wedge, whence its name (σφην, a wedge; ειδος, like); its form has been likened to that of a bat with its wings extended; and the comparison is not very far-fetched, particularly if the ethmoid bone remains attached, as often happens. Like other irregular bones, it may be divided into body and processes.

Fig. 42.

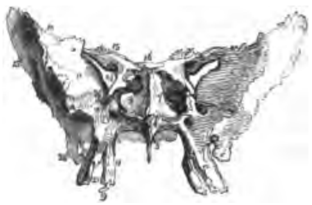


To place this bone in its proper position so as to perceive clearly the relations of its different parts, observe that it has two thick processes somewhat like legs. Hold it so that these shall project downwards, as if from beneath the body and wings, and let those edges of the processes which are channelled into vertical grooves look backwards.

123. *Of the body*, or central part of the bone.—To give precision to its description we say that it presents six aspects or surfaces, each of which looks in a different direction and has distinct relations:—The superior surface, which forms part of the basis of the skull, is of limited extent, yet is hollowed into a deep pit, 1, which lodges the pituitary gland: hence this excavation is called *pituitary fossa*, and sometimes "sella Turcica," from some resemblance to a Turkish saddle (ephippium). On either side of the fossa the surface is depressed, 2, and corresponds with the cavernous sinus; farther back are two superficial grooves, 3, directed from behind forwards, which correspond with the internal carotid arteries. Before the fossa, is a slightly depressed portion of the bone, on a level with the optic foramina, on which rests the commissure of the optic nerves;—behind it, is a prominent ascending lamella, of a square form, and sloping backwards, so as to be continuous with the basilar

groove of the occipital bone: the corners of this lamella project over the fossa, and are called the *posterior clinoid processes*, 4, (κλινη, a bed).

Fig. 43.



The inferior surface is the narrow interval between the pterygoid processes; it is intersected by a prominent spine, fig. 43, 5, called the *rostrum* or azygos process, which dips downwards and forwards to join the vomer. At each side are two small and slightly everted lamellæ (projecting from the base of the pterygoid processes), which articulate with the margins of the vomer. Farther out is a small groove, 6, which contributes with the head of the palate bone to form the *pterygo-palatine canal.*

The anterior surface is very irregular, and presents the openings of two deep sinuses, 7, into which the bone is hollowed: these sinuses (*sphenoidal*) do not exist in young children; in the adult, in whom they are of considerable size, they are separated by a thin partition (septum sphenoidale), which is continuous inferiorly with the rostrum, and in the front articulates with the central lamella of the ethmoid bone. The sinuses are covered in anteriorly by two thin osseous plates, 8, the *sphenoidal spongy bones* (cornua sphenoidalia, cornets sphenoïdaux); these do not, however, altogether seal up the sphenoidal sinuses, but leave a circular aperture, by which they communicate with the posterior ethmoidal cells. In early life they are distinct, and easily separable; but in the adult they become united either with the margins of the sinuses or with the ethmoid or the palate bone.

The posterior surface, fig. 42, 9, is flat, and united with the basilar process of the occipital bone,—in early life by cartilage, but in adult age by osseous matter.

The lateral surfaces are continuous with the great wings, which branch out from them on either side.

124. *Of the processes.*—The principal processes are, the great wings, the small wings, and the pterygoid processes; the

minor ones are the ethmoid spine, processus olivaris, clinoid processes, the rostrum, the hamular and spinous processes.

The *great wings*, 10, (alæ majores,) project outwards, forwards and upwards, from the sides of the body of the bone, and are so formed as to present each three surfaces, looking in different directions; one, anterior, 11, (*orbital*,) is square, smooth, inclined obliquely forwards, and forms part of the outer wall of the orbit; the second, 12, (superior or *cerebral*,) of much greater extent, is elongated from behind forwards, and concave, so as to form part of the middle fossa of the basis of the skull, which supports the middle lobe of the brain; the third, 13, (external or *temporal*,) looks outwards into the temporal fossa, where it forms part of the side of the cranium. It is elongated from above downwards and slightly hollowed. But it will be observed that this surface, taken as a whole from the top of the wing down to the root of the pterygoid process, presents two parts divided by a slight ridge, 14; of these the upper and longer one just noticed forms part of the temporal fossa, and the inferior or smaller division, of the zygomatic fossa.

The *small wings*, 15, (alæ minores,) called also wings of Ingrassias, are triangular in form, horizontal in direction, and extended forwards and outwards, on a level with the upper surface of the body—its fore-part. Their upper surface, plain and flat, supports part of the anterior cerebral lobes, the inferior one overhangs the back part of the orbit and the sphenoidal fissure. The anterior border, sharp, thin, and rough, articulates in the greater part of its extent with the orbital plate of the frontal bone, and internally, at the middle line, where the bases of the two processes are united, there is a slight angular process, 16, (*ethmoidal spine*,) which articulates with the cribriform lamella of the ethmoid bone. The posterior border, rounded and smooth, is free and unattached, and corresponds with the fissure (fissura Sylvii) which separates the anterior from the middle lobe of the brain. The external and anterior ends of these processes are sharp and pointed, whilst posteriorly they terminate in two blunt tapering productions, 17, which incline obliquely backwards, towards the pituitary fossa, and overlay the cavernous sinuses. These are called *anterior clinoid processes*.

125. The *pterygoid* processes are seen at the inferior surface

of the bone, from which they project down like legs rather than wings, though the name given to them would indicate the reverse (πτερυξ, a wing). Each of these consists of two narrow plates (*pterygoid lamellæ*), united at an angle in front, and diverging behind, so as to form an angular groove (*pterygoid fossa*). The internal plate, 18, longer and narrower than the external, is prolonged into a slight round process, 19, named, from its crooked form, the hook-like or *hamular process*, round which plays the tendon of the tensor palati muscle. The external lamella, 20, looks outwards, and somewhat forwards, bounds the zygomatic fossa, and gives attachment to the external pterygoid muscle. At the root of the internal lamella is situated a slight depression (*fossa navicularis*), which gives attachment to the tensor palati muscle; in the groove or fossa, between the two plates, arises the internal pterygoid muscle. The groove is incomplete at its lower part when the sphenoid bone is examined by itself; for an angular interstice, 21, exists between the pterygoid lamellæ. This, however, is filled up by a part of the pyramidal process of the palate bone, which is inserted between the margins of the lamellæ.

126. The *ethmoid spine*, already noticed, is a very small angular plate, 16, which projects forward on a level with the upper surface of the lesser wings in the middle line, and articulates with the cribriform lamella of the ethmoid bone.

The *processus olivaris* is a minute elevation, 22, seen on that depressed piece of bone on a level with the optic foramina, and which supports the commissure of the optic nerves.

The *clinoid* processes are two pair, 17, 4, one before, the other behind the pituitary fossa; therefore called anterior and posterior. A spicula of bone often passes from the anterior to the posterior clinoid process at one or both sides; and occasionally one dips down from this to the body of the bone.

The *rostrum* is the prominent angular ridge, 5, which projects downwards from the under or guttural surface of the bone, dividing it into two parts.

The *hamular* process, 19, projects from the termination of the internal pterygoid plate, is thin, constricted, and curved in the greater part of its extent, but ends in a small blunted tubercle.

The *spinous* processes, 23, are placed at the posterior and inner terminations of the great wings, from which they project downwards about two lines.

127. Each lateral half of the bone presents a fissure, four foramina, and a canal. The fissure, 24, (*fissura sphenoidalis,*) triangular and elongated, is placed between the lesser and greater wings, opens into the orbit, (hence sometimes named foramen lacerum orbitale,) and transmits the third, the fourth, and the sixth nerves, the ophthalmic branch of the fifth and the ophthalmic vein. This fissure is separated at its base from the foramen opticum by a narrow plate of bone which passes from the under surface of the anterior clinoid process (at its root) obliquely down to the body of the sphenoid bone; to this is attached a small tendon, common to the inferior, internal, and external recti muscles of the eye. Of the foramina,—the optic foramen, 25, inclines outwards and forwards on a level with the fore-part of the body of the bone; it transmits the optic nerve and the ophthalmic artery. Farther back and on a lower plane, inasmuch as it is situated in the great wing, is a round aperture, 26, leading forwards; it is the *foramen rotundum,* which transmits the superior maxillary branch of the fifth pair of nerves: a little farther back and more external is a larger foramen, 27, of an oval form, hence called *foramen ovale;* it gives passage to the inferior maxillary branch: near the posterior angle of the ala is the *foramen spinosum,* 28; it is very small, and transmits the middle meningeal artery. The root, or base, of each internal pterygoid process is pierced by a circular foramen, fig. 48, 29, (*pterygoideum,*) more properly a canal, extending horizontally from before backwards, slightly expanded before, narrowed behind, and giving passage to the posterior branch from Meckel's ganglion (*Vidian, pterygoid*).

128. *Articulations.*—The body of the sphenoid bone articulates posteriorly with the basilar process of the occipital, anteriorly with the ethmoid; with the orbital processes of the frontal by the lesser and greater alæ; with the anterior inferior angles of both parietal, and the squamous portion of the two temporal, by the great alæ, and by the spinous processes with the angles between the petrous and squamous portions of that bone: with the vomer it articulates by the rostrum; with the malar bones

by means of the external border of the orbital plates, and with the palate bones by the pterygoid processes;—in all, twelve bones.

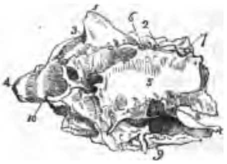
Attachments of muscles.—Round the optic foramen in each orbit are attached the four recti, the obliquus superior, and levator palpebræ muscles; to the external surface of the great ala at each side, the temporal muscle; to the external pterygoid process, the external pterygoid muscle; to the pterygoid fossa, the internal pterygoid; to the inferior half of the internal pterygoid plate, the superior constrictor of the pharynx; and to the fossa navicularis, the circumflexus palati; and to the spinous process, the laxator tympani.

129. *Developement.*—There are two osseous centres in the great wings, two in the pterygoid processes, and two in the small wings. The anterior and posterior segments of the body of the bone commence by distinct points; and as these in some instances unite, one with the great wings and the other with the small ones, before they become joined to one another, this condition of the bone presents an analogy with its permanent state in fishes, reptiles, and most mammalia, in which we find an anterior and posterior sphenoid bone. There appear also two osseous points at the inner borders of the optic foramina.

ETHMOID BONE.

130. The *ethmoid*, or sieve-shaped bone, fig. 44, (*ηθμος*, a sieve; *ειδος*, like; os ethmoides,) is common to the cranium, the orbits, and the nasal fossæ; it is placed at the fore-part of the base of the skull, from which it projects downwards, and is inserted between the orbital plates of the frontal bone, lying behind the nasal and superior maxillary bones, before the sphenoid and above the vomer. It is exceedingly light and thin, considering its size, and seems, at first, but a collection of irregular cells, enclosed between plates of bone as thin as paper. It is of a cuboid figure, symmetrical, and composed of two lateral masses, between which is interposed a central vertical plate. This points out a mode of dividing the bone for the purpose of de-

Fig. 44.



scription, but it is more convenient to consider it as a whole, and examine separately each of its six surfaces.

To place the bone in its proper position, observe that its upper surface is the one from which arises a smooth angular process like a cock's comb. The short border of this looks forward, and the long sloping one backwards.

131. The superior, or *cerebral* surface of the bone, is at once recognised by its presenting a triangular process, which projects upwards from it, in the middle line; this process, 1, from some resemblance to a cock's comb, is called *crista galli.* The surface of the crista is smooth and compact, its form triangular, the base being horizontal, and on a level with the cribriform plate, below which it is continuous with the perpendicular lamella forming the septum narium; the posterior border of this process is long, and slopes backwards, but the anterior is short, and nearly perpendicular; at its junction with the base two small bony masses sometimes project forwards, leaving between them a fissure which forms part of the "foramen cæcum," placed in the middle line at the junction of this bone with the frontal. The crista galli is usually perpendicular, but occasionally inclines to one side; it is sometimes bulged a little at the sides, and is then found to enclose a small sinus; it gives attachment to the falx cerebri, the two layers of which in a manner embrace it.

Beside and behind the crista is the sieve-like or *cribriform lamella*, 2, (lamella cribrosa). It consists of a narrow plate of bone, pierced by a number of holes, from which it derives its name; posteriorly this plate of bone is, for a very little way, even and horizontal; it then becomes depressed into two grooves, beside the crista, which lodge the ganglia of the olfactory nerves. This part of the surface is narrow, elongated from behind forwards, and pierced by numerous foramina, for the transmission of the filaments of the olfactory nerves. The foramina in it are of three sorts: those which lie along the middle of the groove are mere holes or perforations which permit the filaments of the nerves, with their membranous investments, to pass down to the roof of the nares; the external and internal rows are larger, and form the orifices of small canals, which are grooved in the bone, and subdivide as they descend into the septum and spongy bones. In the anterior border of the cribriform lamella, and close to the crista galli, is a fissure at each side of its base, which transmits the nasal filament of the ophthalmic nerve. Along the outer margin of the cribriform plate we observe several small cellules, which are open, and, as it were, incomplete when the bone is detached from its natural situation, but are closed in by the orbital plates of the frontal bone, and completed by a junction with the cells observed in their border. At the posterior margin of this surface, and in the middle line, is a slight notch, which receives the ethmoid spine of the sphenoid bone.

The anterior surface of the bone presents in the middle the edge of the perpendicular or nasal lamella, 4; at the sides of this are narrow grooves which separate it from the lateral masses, and form the upper part of the nasal fossæ; still farther out are some open cellules, which when the bone is in its place are closed by the ascending process of the superior maxillary bone.

The posterior surface presents also in the middle the edge of the perpendicular lamella, then the grooved posterior margins of the ethmoidal turbinate bones, and still more externally large open cellules which are closed by the sphenoid bone and its turbinate bones, and lower down by the head of the palate bones.

The lateral or orbital surfaces are smooth and plain, 5; each is formed of a thin plate of bone, (lamella plana; os planum,) which lies in the inner wall of the orbits.

132. Thus far we can proceed with our description of the bone as if it were a single piece, which presented several aspects, each requiring to be noticed; but when we look at it from below we find it expedient to consider it as divisible into a central or median plate, and two lateral parts or masses.

The inferior, or *nasal* surface of the bone, is of considerable extent, and presents in the middle line a flat plate of bone, and two lateral masses separated from it by a narrow interval: these lateral parts are formed of thin plates, enclosing cellules, which appear so complex as to be likened by some persons to a labyrinth. The descending or *nasal* plate (lamella nasalis), called also the perpendicular plate, though it frequently inclines to one side, forms a considerable part of the septum nasi; it is continuous above with the base of the crista galli, as already stated; below, it articulates with the vomer and the triangular cartilage of the nose; its anterior margin joins by its upper part with the nasal process of the frontal bone, and lower down supports the ossa nasi; the posterior margin articulates with the septum sphenoidale. This plate presents a number of grooves and minute canals, leading from the foramina of the cribriform lamella, for the transmission of the olfactory nerves: in the natural condition it is covered by the pituitary membrane.

133. *Lateral masses.*—The external surface of each of these consists of a thin, smooth, and nearly vertical plate of bone, 5, (*lamella plana, os planum,*) which closes in the ethmoidal cells, and forms a considerable part of the inner wall of the orbit: it articulates above with the orbital plate of the frontal bone; below, with the superior maxilla and palate bone; in front, with the os unguis; and behind, with the sphenoid. At its anterior and posterior margins, the ethmoidal cells are open when the bone is detached from its connexions; in the former situation they are closed by the os unguis; in the latter, by the sphenoid spongy bones. In its upper margin are two grooves, 6, 7, which are formed into foramina by similar indentations in the frontal bones, and so form the internal orbital foramina *(foramen orbitarium internum, anterius et posterius).*

134. The inner surface of each lateral mass forms part of the external wall of the corresponding nasal fossa, and consists of a thin osseous plate, connected above with the cribriform lamella, from which it hangs down, and below ends in a free margin, which is convoluted a little, and represents the middle spongy bone. At its upper and fore part, is a square, flat, but rough surface, which is pierced by a number of grooves, leading from the foramina of the cribriform lamella; posteriorly are placed two thin and also rough osseous plates, curved a little, so as to represent small bivalve shells, from which circumstance they are called ethmoidal *turbinate* bones; but from their texture, being cellular and porous on the surface, they are named spongy bones. Of these, the first or upper one, 8, (concha superior,) which is also placed farther back, is very small; by the curve or coil which it makes it arches over, and forms a groove or channel (*meatus naris superior*): this is of small extent from before backwards, not being more than half that of the ethmoid bone; it communicates with the posterior ethmoidal cells, and the

sphenoidal sinuses. Still lower down is another osseous lamella, 9, thin, rough, and convoluted, which is the second ethmoidal spongy or turbinate bone. Its lower margin is more rough and prominent than that of the upper one, and its extent from before backwards nearly double. Beneath this is a groove or channel which it overhangs so as to form the second *meatus naris*, which communicates with the anterior ethmoidal cells and the frontal sinuses.

135. The osseous rough plate here described gives attachment by its outer surface to a number of osseous lamellæ, thin and delicate, which pass across the space between it and the lamella plana, dividing it into a number of cells (*ethmoidal*). These do not all communicate: they are separated into two sets by a sort of transverse partition, the posterior being small and few in number—from four to five,—whilst the anterior, larger and more numerous, communicate with the frontal sinus. The cellule, 10, which directly communicates with the middle meatus, is prolonged, in a curved direction, upwards and forwards, opening by a small aperture into the anterior ethmoidal cells, and by another, farther on, into the frontal sinus; and, as it is broad below and tapering above, it assumes somewhat the form of a funnel, and hence is named *infundibulum*.

The superior border of each lateral mass presents some incomplete cells, before noticed, when describing the cribriform plate; the inferior gives off some irregular lamellæ, which articulate with the side of the maxillary sinus and the inferior turbinate bone; the anterior also exhibits some incomplete cells, which are closed in by the os unguis and the nasal process of the superior maxillary bone.

136. *Articulations.*—The ethmoid articulates with thirteen bones—the frontal, the sphenoid, and vomer, two nasal, two ossa unguis, two superior maxillary, two palatal, and two inferior spongy bones.

Developement.—There is an ossific centre in each lateral mass, and one in the perpendicular lamella.

OSSA TRIQUETRA.

137. Accidental, or supernumerary bones, are not unfrequently found in skulls. From their form, which is very variable, they are sometimes called triquetra, at others, triangularia,

or ossa Wormii, from Wormius the anatomist, who is said to have given the first detailed description of them. They are osseous plates, with serrated margins, inserted, as it were, between two cranial bones, and appearing like islets placed in the sutures. Their most ordinary position is in the lambdoid suture, next in the sagittal, seldom if ever in the coronal, never in the squamous. The superior angle of the occipital bone sometimes occurs as an accessory piece; so does the anterior inferior angle of the parietal. They are not found before the sixth or eighth month after birth; and, whatever varieties of size and appearance they may present, the principle of their formation is the same in all cases. As the broad bones grow by successive deposits, extending from their central points towards the margins, whenever the natural process is retarded or interrupted, the mode of osseous deposition takes a new direction, a new centre is established in the layer of cartilage between the margins of the bones, and therefore in the situation of the suture, from which it extends outwards, until it comes into contact with the margins of the contiguous bones, with which it becomes united in the usual way by suture.

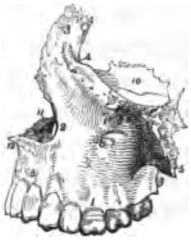
BONES OF THE FACE.

These, as above stated (Sect. 113), are fourteen in number.

THE SUPERIOR MAXILLARY BONE.

138. This bone, fig. 45, (maxilla superior,) is very irregular ; it presents an external convex surface, corresponding with the anterior and lateral parts of the face ; another, internal, of considerable extent, corresponding with the nasal cavity ; one, superior, smooth, and inclined inwards, forming the floor of the orbit, and surmounted internally by a triangular process, forming the side of the nose ; lastly, a surface which projects horizontally inwards, to form the arch of the palate. The external surface is bounded inferiorly by a thick, dependent border (alveolar), for the lodgment of the teeth ; to this, as to a common point of union, all the other parts of the bone may be referred.

Fig. 45.



139. The alveolar border, 1, thick, semicircular, convex externally, concave internally, is pierced along its margin by a number of deep pits (*alveoli*), into which the teeth are inserted. The pits or sockets vary in form and depth, conforming in these particulars to the roots of the teeth which they receive. From this border the external side ascends upwards to the margin of the orbit, presenting some depressions and elevations; but at its fore-part it is interrupted and excavated so as to present a deeply concave margin, 2, which, with a similar one in the corresponding bone, forms the anterior nares. This excavation is surmounted by a process, 3, (*ascending* or *nasal*) prolonged as far as the frontal bone, with which it articulates. The external surface of this process, slightly grooved, gives attachment to the orbicularis palpebrarum muscle and the levator labii superioris alæque nasi. The internal, or nasal surface, somewhat concave, presents a rough line, running from before backwards, which articulates with the inferior spongy bone; above this is a depression corresponding with the middle meatus of the nose, and, towards the summit, a rough surface, which closes in the anterior ethmoidal cells. The anterior border is rough, for its attachment to the nasal bone; the posterior presents a well-marked groove, 4, running from above downwards, and a little backwards with a slight curve, and which is completed into a canal by a similar one in the os unguis, for the lachrymal sac.

140. The part of the external surface a little above the molar teeth, is elevated into a rough projection, 5, (*malar eminence,*) for its articulation with the malar bone. Anterior and inferior to this is observed a fossa, 6, (*fossa canina,*) which gives attachment to the levator anguli oris. Between this fossa and the margin of the orbit is the infra-orbital foramen, 7, which transmits the superior maxillary nerve. A little above the sockets of the incisor teeth is a slight depression, 8, (myrtiform fossa) which gives attachment to the depressor muscle of the ala of the nose. Behind the malar tuberosity the surface is slightly excavated, and forms part of the zygomatic fossa; towards the posterior border it is plain, and forms one side of the spheno-maxillary fissure; and, at its junction with the orbital plate, it is rounded off and leads to the entrance of the infra-orbital canal. This surface is pierced by a number of foramina, which transmit the superior dental nerves; it terminates by a slight tuberosity, 9, which

projects behind the last molar tooth. The inner surface of its posterior border is rough, for its attachment to the tuberosity of the palate bone, and presents also a slight groove, contributing to the formation of the *posterior palatine canal*, which transmits the descending palatine branches from Meckel's ganglion.

From the upper border of the external surface, the *orbital plate*, 10, projects inwards, forming the floor of the orbit ; its surface is smooth, being merely interrupted by the groove which leads to the infra-orbital canal ; and at its inner and fore part near the lachrymal groove is a minute depression, which gives origin to the inferior oblique muscle of the eye.

141. The horizontal or *palate* plate of the bone projects inwards, forming the roof of the mouth, and the floor of the nares. Its nasal surface is concave from side to side, and smooth ; externally it is continuous with the body of the bone, internally it presents a rough surface, which is articulated with the corresponding bone, and surmounted by a ridge, 11, which completes the septum narium by articulating with the vomer and nasal cartilage ; in front it is prolonged a little, so as to form a small process, 12 (anterior nasal spine) ; beside it is the foramen, leading into the anterior palatine canal, which lodges the naso-palatine ganglion. The inferior surface of the palate plate is rough, arched, and overhangs the mouth.

The body of the bone is hollowed into a large cavity, *antrum Highmori*, or *maxillare*, which in the fresh state is lined by mucous membrane and communicates with the middle meatus of the nose. Its orifice appears of great size in the dried bone when detached from its connexions, but it is considerably diminished when the contiguous bones are in their natural position, viz. the ethmoid, the inferior turbinate, and the palatal.

142. *Articulations.*—With the corresponding bone ; with the frontal, by its nasal process ; also with the ethmoid and os nasi ; with the palate bone ; with the malar, by the malar eminence ; with the os unguis, the vomer, the inferior spongy bone, and the nasal cartilage.

Attachments of muscles.—Proceeding from below upwards ;—above the border of the alveolar arch, the buccinator, and the depressor labii superioris alæque nasi ; to the canine fossa, the levator anguli oris, and the compressor nasi ; to the margin of the orbit, part of the levator labii superioris ; to the nasal process, the orbicularis palpebrarum, and the common elevator of the lip and ala of the nose; and just within the orbit, the inferior oblique muscle of the eye.

Developement.—In this case there are several ossific centres,—one in the nasal process, one in the orbital, one in the body, and one or two in the palate process. If the growth be interrupted, the fore part of the alveolar border with a portion of the palatal arch may remain separate from the rest of the bone, and represent an inter-maxillary bone.

THE MALAR BONE.

143. The malar bone (os malæ), common to the face and orbit, forms the most prominent point of the side of the former, and the greater part of the outer border of the latter. Its form is quadrangular. The facial or anterior surface, pierced by some foramina for small vessels, is convex, and gives attachment to the zygomatic muscles;—the posterior overlays the zygomatic fossa, and is rough at its fore part for its articulation with the superior maxillary bone. The superior surface, smooth, narrow, and lunated, extends into the orbit, and articulates with the frontal, sphenoid, and superior maxillary bones.

The superior border forms the outer margin of the orbit; the inferior is on a line with the zygomatic arch, which it contributes to form; the anterior articulates with the maxillary bone; the posterior, curved, gives attachment to the temporal aponeurosis.

Articulations.—It articulatcs with the frontal, superior maxillary, temporal, and sphenoid bones.

Attachments of muscles.—The zygomatici, to its anterior surface; the masseter, to its inferior border; to its anterior angle, part of the levator labii superioris.

Developement.—It grows from a single ossific point.

THE NASAL BONES.

144. The nasal bones (ossa nasi), situated beneath the frontal bone, and between the ascending processes of the superior maxillary, are small, and irregularly quadrilateral, and form what is called the "bridge" of the nose. They are thick and narrow in their upper part, but gradually become wider and thinner lower down. The anterior surface of each, concave from above downwards, convex from side to side, presents a minute vascular foramen; the posterior, or nasal, is marked by the

passage of a branch of the nasal nerve; the superior border articulates with the frontal bone; the inferior with the nasal cartilage; the external with the ascending process of the maxillary bone; the internal with its fellow of the opposite side, and is supported by the nasal spine of the frontal bone, and the perpendicular plate of the ethmoid.

They give attachment to the pyramidales and compressores nasi; and are developed each from a single osseous centre.

OS UNGUIS—OS LACHRYMALE.

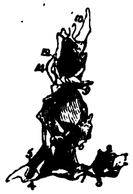
145. This small bone is named "ungual" from a resemblance, if not in form, at least in thinness and size, to a finger-nail (unguis); it is also called the "lachrymal" bone, from its presenting a groove which, with a similar excavation in the nasal process of the superior maxilla, forms the lachrymal groove. Placed at the inner and anterior part of the orbit, it presents two surfaces and four borders; its external or orbital surface, plain in the greater part of its extent, is hollowed anteriorly by a groove which runs from above downwards, and contributes, as above stated, to lodge the lachrymal sac. Part of the internal surface, which is rough, corresponds with the anterior ethmoidal cells, the rest with the middle meatus narium. The superior border is articulated with the orbital process of the frontal bone; the inferior with the superior maxillary bone; and where it dips down, to form a part of the lachrymal canal, it joins the inferior spongy bone; anteriorly, it rests on the nasal processes of the superior maxillary bone, and posteriorly on the os planum of the ethmoid.

It is developed from one osseous centre.

THE PALATE BONE.

146. The palate bone, fig. 46, (os palati,) wedged in between the superior maxillary and sphenoid bones, is common to the cavity of the mouth, nares, and orbit. In its form this bone somewhat resembles that of the letter L, one part being horizontal, the other vertical.

Fig. 46.



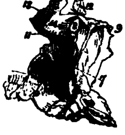
147. The horizontal or *palate* plate, 1, of the bone, which is nearly square, and forms the back part of the roof of the mouth and of the

floor of the nares, articulates anteriorly with the palate plate of the maxillary bone; internally, it presents a rough thick border which rises up into a ridge, 2, which joins with its fellow of the opposite side, and with it forms a groove which receives the lower border of the vomer; externally it unites at right angles with the vertical portion of the bone; posteriorly it presents a thin free border, forming the limit of the hard palate, and giving attachment to the velum or soft palate which projects downwards from it; it is slightly concave, and has at the inner angle a pointed process, 3 (*the palate spine*). The superior surface of this plate or process is smooth, and forms the back part of the floor of the nasal cavity: the inferior, which forms part of the roof of the mouth, is unequal, and marked by a transverse ridge, into which the tendinous fibres of the circumflexus palati muscle are inserted; it presents also an oval foramen, being the inferior termination of the posterior palatine canal, which transmits the large descending palatine nerve and accompanying vessels; and farther back, another of smaller size, which transmits the middle palatine nerve.

At the junction of the horizontal and vertical portions, is situated a thick, rough tubercle, 4, (*tuberosity, pyramidal process,*) projecting downwards and backwards. This is marked by three vertical grooves; the two lateral ones are rough, and receive the inferior borders of the pterygoid plates of the sphenoid bone; the middle one, 5, smooth, corresponds with and completes the fossa between the pterygoid plates.

148. The vertical portion of the bone is flat and thin; it presents two surfaces; the internal one (*nasal*) is divided into two parts by a transverse ridge, 6, which articulates with the inferior spongy bone; the space below the ridge forms part of the inferior meatus, that above it of the middle meatus. The external surface, rough and unequal, fig. 47, is divided by a vertical groove, 7, which is completed into a canal (*posterior palatine canal*) by the maxillary bone. The posterior part of this surface articulates with the rough border and nasal surface of the maxillary bone; and the anterior, thin and scaly, with the side of the antrum.

Fig. 47.



The superior border of the vertical portion of the palate bone presents a notch, 8, forming the greater part of a foramen, which is completed by the sphenoid bone when the parts are in their natural position. This is called the *spheno-palatine* foramen; and outside it is placed the nervous ganglion of the same name (Meckel's ganglion). This notch divides the border of the bone into two processes or heads, the sphenoidal and the orbital.

149. The *sphenoidal* process, 9, smaller and not so prominent, presents three surfaces, of which one, internal, looks to the nasal fossa; another, external, forms a small part of the zygomatic fossa; and the third, superior, grooved on its upper surface, articulates with the under surface of the sphenoid bone, and with it forms part of the *pterygo-palatine* canal.

150. The *orbital* process, 10, inclines outwards and forwards, and has five surfaces, two of which are free, and three articulated; of the latter, the internal one rests against the ethmoid bone, and covers some of its cellules; the anterior, 11, articulates with the superior maxillary bone; and the posterior, 12, (which is hollow) with the sphenoid. Of the non-articular surfaces, one superior, 13, smooth and oblique, forms a small part of the floor of the orbit; the other, external, 14, looks into the zygomatic fossa.

Articulations.—With the corresponding palate bone; with the maxillary, ethmoid, sphenoid, vomer, and inferior spongy bone.

Muscular attachments.—To its spine, the azygos uvulæ; to the centre groove on its tuberosity, a small part of the internal pterygoid; and to the transverse ridge on the palate plate, the aponeurosis of the circumflexus palati.

Developement.—From the position and complex relations of this bone, its mode of growth is difficult to be determined. It appears at first like a single osseous plate slightly curved, and produced from one centre of ossification.

THE VOMER.

151. The vomer, so called from its resemblance to a ploughshare, is flat, irregularly quadrilateral, and placed vertically between the nasal fossæ, presenting two surfaces and four borders. The lateral surfaces form part of the inner wall of the nasal fossæ; the superior border, thick and deeply grooved, receives the rostrum of the sphenoid bone; the margins of the groove

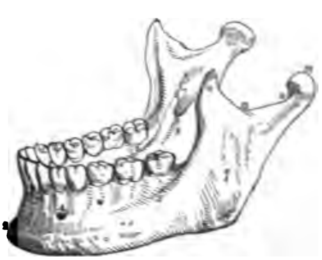
expand and are articulated with two small lamellæ at the roots of the pterygoid processes of the sphenoid bone. The anterior border, also grooved, presents two portions, into one of which is implanted the descending plate of the ethmoid, and into the other the nasal cartilage. The posterior border, dividing the posterior nares, is thin and unattached: the inferior is received into the fissure formed by the palate plates of the superior maxillary and palate bones. It is developed from a single osseous centre.

THE INFERIOR TURBINATE BONE.

152. The *inferior turbinate*, or *spongy bone*, (so called from its texture in the latter case, in the former from some resemblance to the lateral half of an elongated bivalve shell,) extends from before backwards, along the side of the nasal fossa:—it appears as if appended to the side of the superior maxillary and palate bones. It is slightly convoluted, and presents an internal convex surface, projecting into the nasal fossa; and an external concave one, which arches over the inferior meatus. Its superior border articulates with the ascending process of the maxillary bone before, with the palate bone behind, and in the centre with the os unguis; it presents also a hooked process, which curves downwards and articulates with the side of the antrum; the inferior border is free, slightly twisted, and dependent. It has one point of ossification.

THE INFERIOR MAXILLARY BONE.

Fig. 48.



153. The inferior maxilla, fig. 48, (os maxillæ inferior,) is of considerable size, and forms a large portion of the sides and fore part of the face. It is convex in its general outline, and shaped somewhat like a horseshoe. It is usually considered as divisible into a middle larger portion — its body, and two branches or rami. The *body*, 1, is placed horizontally; its external surface is convex, and marked at the middle by a verti-

cal line, 2, indicating the original division of the bone into two lateral parts, and thence named its *symphysis.* On each side of the symphysis, and just below the incisor teeth, is a superficial depression, 3, (the *incisor fossa,*) which gives origin to the levator menti muscle; and, more externally, a foramen, 4, (*foramen mentale,*) which transmits the terminal branches of the dental nerve and artery. A raised line may be observed to extend obliquely upwards and outwards from near the symphysis to the anterior border of the ramus; it is named the *external oblique* line, 5, and is intended to give attachment to muscles. The internal surface of the body of the bone is concave in its general outline, and marked at its centre by a depression corresponding with the symphysis; at each side of which are two prominent tubercles placed in pairs, one above the other, and affording attachment,—the upper pair, to the genio-hyo-glossi, and the lower to the genio-hyoidei muscles; beneath these are two slight depressions for the digastric muscles. An oblique prominent line, 6, (the *mylo-hyoidean ridge,*) will be observed leading from the lower margin upwards and outwards to the ramus; above the line is a smooth depression for the sublingual gland, and beneath it, but situated more externally, is another for the submaxillary gland. The superior border of the body is horizontal, and marked by notches, corresponding with the alveoli, or sockets of the teeth. The inferior border, thicker at its anterior than at its posterior part, is slightly everted, so as to project somewhat forwards.

154. The branches, 7, (*rami,*) project upwards from the posterior extremity of the body of the bone, with which they form nearly a right angle in the adult, an obtuse one in infancy,—the "angle" of the jaw. They are thinner somewhat, and appear as if compressed. The external surface of each ramus is flat, and marked by slight inequalities; the internal surface presents at its middle a foramen, 8, (*inferior dental,*) leading into a canal (dental) contained within the bone, and lodging the dental nerve and vessels. Beneath the foramen, a slight groove, 9, marks the passage of some vessels and a nerve, the rest of the surface being rough, for the insertion of the pterygoideus internus. The anterior border of each ramus is nearly vertical in its direction, and terminates in a pointed extremity, named the *coronoid process,* 10; it is grooved at its commencement, for

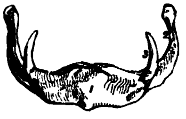
the attachment of the buccinator muscle. The posterior border is also almost vertical in adults; but in children and edentulous subjects it departs considerably from this direction, and approaches that of the base of the bone. This border is surmounted by a constricted part, 11, which appears as if compressed from before backwards, and is called the *neck* of the bone. It is slightly depressed at its fore part, and gives insertion to the external pterygoid muscle. Now the neck supports the articular head of the bone, 12, (the *condyle*,) which is convex and oblong, its greatest diameter being from without, inwards; the direction of its axis is oblique, so that, if prolonged, it would meet with that of its fellow of the opposite side at the anterior margin of the foramen magnum. The interval between the condyle and the coronoid process, deeply excavated, is called the *sigmoid* notch, and if viewed when the bones are *in situ*, it will be found to form a complete circle with the arch of the zygoma.

155. *Attachments of muscles.*—To the incisor fossa, the levator menti; to the external oblique line, the depressor labii inferioris, depressor anguli oris, and a small part of the platisma myoides. To the upper tubercles on the inner surface of the symphysis, the genio-hyo-glossi; to the inferior ones, the genio-hyoidei; to the depression beneath these, the digastricus; to the internal oblique line, the mylo-hyoideus, and posteriorly a small part of the superior constrictor of the pharynx. To the external surface of the ramus, the masseter; to the lower part of the inner surface, the pterygoideus internus; to the neck of the condyle, the pterygoideus externus; to the coronoid process, the temporal.

Developement.—The growth is here effected from two osseous points, one in each lateral half.

OS HYOIDES.

Fig. 49.



156. This is the u-shaped bone, fig. 49, so named from some resemblance to the Greek letter *υ*. It is occasionally called the lingual bone, from its important relations with the tongue; it is situated at the base of the tongue, and may be felt between the chin and the thyroid cartilage. It consists of a body,

two cornua, and two cornicula. The body or central piece, 1, is small, quadrilateral in its form, and appearing as if compressed from before backwards; hence the direction of its plane is nearly vertical; but the great cornua seem as if compressed from above downwards, so that their plane appears horizontal. The anterior surface of the body is convex, and marked at the middle by a vertical line, on each side of which are depressions for the attachment of muscles; its posterior surface is concave, and corresponds with the epiglottis. The cornua, 2, project backwards, and end in a rounded point. The cornicula, 3, short, irregularly conical in their form, and oblique in their direction, are placed at the junction of the body with the cornua, and give attachment to the stylo-hyoid ligament; they continue for a long time movable, as the cartilage which connects them remains unossified to an advanced period of life.

157. *Attachments of muscles and ligaments.*—The stylo-hyoid ligaments, to the cornicula; the thyro-hyoid, to the cornua. The anterior surface gives attachment to the stylo-hyoid, sterno-hyoid, and digastric muscles; the superior border, to the mylo-hyoid, genio-hyoid, genio-hyo-glossi, lingualis, hyo-glossus, and the middle constrictor of the pharynx; its lower border, to the omo-hyoid and thyro-hyoid muscles, and more internally to the thyro-hyoid membrane.

THE SUTURES.

158. The bones of the skull, and those of the face, are joined together by seams or sutures. The cranial sutures are commonly said to be five in number, of which three are termed true, as the margins of the bones are, in a manner, dove-tailed one into another; and two are called false, or squamous, as they merely overlap one another, like the scales of fishes. The true sutures are, the coronal, the lambdoidal, and the sagittal. These names are obviously ill-chosen; they convey no notion of the position which the sutures occupy in the skull or of the bones which they connect.

159. The *coronal* suture (sutura coronalis) has been so named from being situated where the ancients wore their garlands (coronæ). It connects the frontal with the two parietal bones, and hence it may with more propriety be called "fronto-parietal." It commences at each side about an inch behind the

external orbital process of the frontal bone, where the anterior inferior angle of the parietal articulates with the great wing of the sphenoid bone. From this point it mounts rather obliquely up towards the vertex, having an inclination backwards. The dentations are better marked at the sides than at the summit of the head, for in the latter situation the suture approaches somewhat the squamous character, to allow the frontal bone to overlap the parietal. A similar change takes place at its lower part or commencement, with this difference, that there the parietal bones are made to overlay the frontal.

160. The *lambdoid* suture (sutura lambdoidalis) is situated between the occipital and the parietal bones, its form resembling somewhat that of the Greek letter Λ, whence its name has been taken. It begins at each side on a line with the posterior inferior angle of the parietal bone, and thence inclines upwards and forwards to the point at which the two parietal bones are joined by the sagittal suture. It thus represents two sides of a triangle. It is often interrupted by accessory osseous deposits (ossa Wormiana). From its position and relation this suture may be named " occipito-parietal."

161. The *sagittal* suture (s. sagittalis—sagitta, an arrow) extends directly backwards, from the middle of the coronal to that of the lambdoid suture, and connects the two parietal bones, from which circumstance it may be called the " inter-parietal " suture: in children, and occasionally in adults, it is prolonged through the frontal bone, even to the root of the nose. The serrated appearance of the sutures is perceptible only on the external surface of the bones; the internal surface, or table of each, as it is called, being merely in apposition with the contiguous bone.

The line of union between the occipital and the temporal bone at each side used to be considered as a continuation of the lambdoid suture, or as an appendix to it, and was accordingly named *additamentum suturæ lambdoidalis.* It may, however, be named *temporo-occipital,* as it connects the mastoid and petrous parts of the temporal bone with the occipital—principally its basilar and condyloid portions. In this suture there are no regular dentations; in a great part of its extent the margins of the bones are merely in apposition.

162. The *squamous* sutures (suturæ squamosæ) are arched,

and mark the junction of the lower borders of the parietal bones with the squamous parts of the temporal, their edges being so bevelled off as to allow the latter to overlay the former. At the point of junction between the squamous and mastoid parts of the temporal bone, the true squamous suture ceases; but from thence a short suture runs backwards to the lambdoid, connecting the mastoid part of the temporal with the postero-inferior angle of the parietal. This is termed *additamentum suturæ squamosæ:*—both together form the "temporo-parietal" suture.

The line of direction of the sutures (particularly the lambdoid and sagittal) is not unfrequently interrupted by additional bones, inserted between those hitherto enumerated. These, from being sometimes of a triangular form, are called *ossa triquetra*, and also *ossa Wormiana.*

163. The cranial bones are joined to those of the face by sutures, which are common to both sets of bones. The *transverse* suture, observable at the root of the nose, extends across the orbits, and connects the frontal with the nasal, superior maxillary, ossa unguis, ethmoid, sphenoid, and malar bones. The *zygomatic* sutures are very short; they are directed obliquely downwards and backwards, and join the zygomatic processes of the temporal with the malar bones. The *ethmoid* suture surrounds the bone of the same name; so does the *sphenoid ;* they are necessarily complex in consequence of the many relations of these bones. The lines of connexion between the nasal and maxillary bones, though sufficiently marked, have not received particular names; but those observable between the horizontal lamellæ of the latter, and those of the palate bones, may be termed the palato-maxillary sutures.

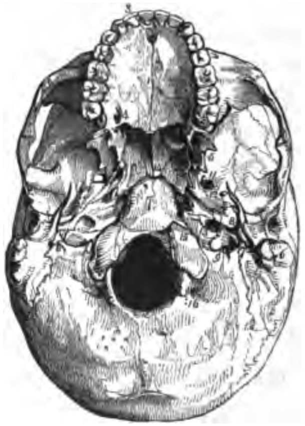
REMARKS ON THE GENERAL CONFORMATION OF THE SKULL.

164. After having described, in detail, the separate bones of the head and face, it becomes necessary to review them collectively. The description of these bones forms the most difficult part of human, as well as of comparative osteology, as they are the most complex in the whole skeleton; but a correct knowledge of them is indispensable, in consequence of the many important parts which they serve to sus-

tain and enclose; viz. the cerebral mass, with its nerves and vessels; the organs of sight, hearing, smell, and taste; part of those of mastication and deglutition, as well as of voice. To facilitate the description of the numerous eminences, depressions, cavities, and foramina of the skull, anatomists examine successively its external and internal surface: the former may be considered as divisible into five regions, three being somewhat of an oval figure, and situated, one superiorly, another at the base, the third in front, including the face; the others comprise the lateral parts, and are somewhat flat and triangular.

165. The *superior region* extends from the frontal eminences to the occipital protuberance, and, transversely, from one temporal ridge to the other; it thus includes the upper broad part of the frontal, almost all the parietal, and the superior third of the occipital bone, which together form the vaulted arch of the skull. It is divided into two symmetrical parts by the sagittal suture and its continuation when it exists; it presents no aperture or other inequality deserving of particular notice; it is covered by the common integument and occipito-frontalis muscle, on which ramify branches of the temporal, occipital, and auricular arteries, as well as filaments of nerves from the frontal branches of the fifth and portio dura, and also from the occipital nerve.

Fig. 50.



166. The *inferior region*, fig. 50, also oval in its outline, is the most complex of all, as it includes the entire base of the skull, extending from the incisor teeth to the occipital protuberance, and transversely, from the mastoid process and dental arch on one side, to the corresponding points on the other. It may be considered as divisible into three parts. Of these, one corresponds with the extent of the arch of the palate; it is divided into two parts, by a line, 1, extending from before backwards, and marking the junction of the palate processes of the superior maxillary and palate bones; this is intersected by another, 2, running transversely between each palate bone and the corresponding maxillary bone. Anteriorly, and in the middle line, is a foramen, 3, (the *anterior palatine*,) which in the floor of the nares is double, but becomes single

inferiorly, and transmits the naso-palatine nerve; posteriorly, on each side, and at the base of the alveolar border, is another foramen, 4, (*posterior palatine,*) for the posterior palatine nerves and artery. The middle, or guttural region, is bounded at each side by a line extended from the pterygoid process, 5, as far as the mastoid process, 6, thus including the posterior aperture of the nares, and the central part of the base of the skull. In the centre is situated the basilar process, 7, of the occipital bone, marked by slight inequalities, for the attachment of muscles, and towards its posterior extremity the anterior condyloid foramina, which transmit the ninth pair of nerves. On each side is the pars petrosa, 8, of the temporal bone, in which may be observed the styloid and vaginal processes; more posteriorly is the jugular fossa, which is completed into a foramen, 9, (*foramen lacerum posterius basis cranii,*) by the border of the occipital bone. This is divided into two parts by a spicula of bone, or a fibrous band, the internal and anterior one serving to transmit the glosso-pharyngeal, par vagum, and spinal accessory nerves; the other the jugular vein. Between the apex of the pars petrosa, and the side of the basilar process, and the body of the sphenoid bone, is the *foramen lacerum anterius basis cranii,* 10, which is closed inferiorly by a thin plate of cartilage: across its area, as viewed at its upper or cerebral aspect, runs the internal carotid artery in its passage from the carotid canal in the temporal bone to the side of the sphenoid, and also the Vidian nerve, after it has passed backwards through the pterygoid foramen, and is proceeding to reach the groove in the upper surface of the pars petrosa. Between the contiguous margins of the pars petrosa and the great ala of the sphenoid bone is a groove, which leads backwards and outwards, and lodges the cartilaginous part of the Eustachian tube; and above the osseous part of that tube, and separated from it by a thin lamella of bone, is the orifice of the canal which transmits the tensor tympani muscle. The foramina of this region, taken in their order, from within outwards and backwards, are, the foramen ovale, 11, foramen spinosum, 12, foramen caroticum, 13, and stylo-mastoideum, 17.

The anterior part of this region is continuous with the posterior aperture of the nares, which is divided into two parts by the vomer, 14. It is bounded above by the body of the sphenoid bone, below by the palate plates of the ossa palati, and on the sides by the pterygoid processes. The pterygoid groove, in each of these processes, is completed inferiorly by the pyramidal process of the palate bone; near its junction with the body of the bone is the scaphoid fossa, for the origin of the circumflexus palati; and at its inferior termination is the hamular process, round which the tendon of that muscle is reflected. Between the base of this process and the posterior palatine foramen is situated a smaller foramen, leading down from the posterior palatine canal, and which transmits the middle palatine nerve.

The posterior part of the inferior region includes all that is situated between the occipital protuberance and a line connecting the mastoid processes. It is divided into two lateral parts by a ridge, extending to the foramen magnum from the occipital protuberance, from which two rough curved lines branch outwards, giving attachment to muscles; so does the space between the lines, and that between the inferior one and the foramen magnum. At the margin of the foramen, but nearer to its anterior termination, are the condyles, 15, of the occipital bone which articulate with the first vertebra; behind each is a depression, 16, (*condyloid fossa,*) and usually a foramen (*posterior condyloid foramen*), which transmits a small vein and artery. Before and a little to the outer side of each, in a spot also retiring and depressed, is the opening of the *anterior condyloid foramen,* which looks obliquely outwards and forwards, and transmits the lingual nerve.

167. The *anterior region* of the skull is of an oval form, and extends from the frontal eminences to the chin, and from the external border of the orbit and ramus of the jaw, on one side, to the corresponding points on the other, so as to include the whole of the face. The eminences, depressions, fossæ, and foramina, observable in this region, are as follow, viz. the frontal eminences, more or less prominent in different individuals, bounded inferiorly by two slight depressions, which separate them from the superciliary ridges; these curve outwards, from the nasal process of the frontal bone. Beneath the superciliary ridge, on each side, is the margin of the orbit, marked at its inner third by a groove, or a foramen, which transmits the frontal nerve and supra-orbital artery; and also by a slight depression, which gives attachment to the cartilaginous pulley of the trochlearis muscle. At an interval corresponding with the breadth of the orbit is another ridge, forming its inferior margin; under which is situated the infra-orbital foramen, for the passage of the superior maxillary nerve; and still lower down, the fossa canina, which gives attachment to the levator anguli oris muscle; it is bounded below by the alveolar border of the upper jaw, and surmounted by the malar tuberosity. Towards the middle line, and corresponding with the interval between the orbits, is the nasal eminence of the frontal bone, which is prominent in proportion to the developement of the frontal sinuses over which it is situated. This is bounded by the transverse suture,

marking the root of the nose. Beneath the nasal, and between the contiguous borders of the superior maxillary bones, is a triangular opening which leads into the nasal fossæ; it is broad below, and there its edge is surmounted by a prominent process, the nasal spine. Laterally it presents two sharp curved borders, which gradually incline inwards as they ascend to the nasal bones, so as to narrow it somewhat. Below the nasal aperture is a slight depression (myrtiform fossa), at each side of the middle line over the alveolus of the second incisor tooth. Farther down is the transverse rima of the mouth, between the alveolar borders of the jaws. In the inferior maxillary bone, besides some muscular impressions, is the mental foramen, which transmits the terminal branches of the dental nerve and artery.

168. The two *lateral* regions of the skull are somewhat of a triangular figure, the apex of the triangle being at the angle of the lower jaw, the base at the temporal ridge, and the sides formed by two lines drawn, one upwards and forwards, over the external orbital process, the other upwards and backwards, over the mastoid process. In consequence of the great irregularity of the surface, it is necessary to subdivide each of these regions into three; the part above the zygoma being called the temporal region or fossa, that beneath it the zygomatic, the remainder being named the mastoid.

The *temporal* region, or fossa, being bounded by the temporal ridge above, and by the zygomatic arch below, is of a semicircular form, and extends from the external angular process of the frontal bone to the base of the mastoid process. It is filled up by the temporal muscle, lodges the deep temporal vessels and nerves, and is formed by the temporal, parietal, frontal, sphenoid, and malar bones.

The *mastoid* region is bounded before by the transverse root of the zygoma, above by the horizontal one and the additamentum suturæ squamosæ, behind and inferiorly by the additamentum suturæ lambdoidalis. Proceeding from behind forwards, we observe the mastoid foramen, the process of the same name; anterior to which is the aperture of the meatus auditorius externus, which is circular in young subjects and somewhat oval in adults, the greatest diameter being from above downwards. The osseous tube continuous, externally, with the fibro-cartilage of the ear, and bounded, internally, by the membrana tympani, is directed, obliquely, forwards and inwards, and is somewhat broader at its extremities than in the middle. Anterior to the meatus is the glenoid fossa, which is bounded before by the transverse root of the zygoma, behind by the meatus, and internally by the spinous process of the sphenoid bone. It is divided into two parts by a transverse fissure (*fissura Glasseri*), the anterior portion being smooth, for its articulation with the condyle of the lower jaw; the posterior, rough, lodges part of the parotid gland. This fissure gives entrance to the laxator tympani muscle and a small artery, and transmits outwards the chorda tympani nerve.

The *zygomatic* region, situated deeply behind and beneath the orbit, is bounded before by the convex part of the superior maxillary bone, and is enclosed between the zygoma and the pterygoid process. The posterior surface of the maxillary bone is pierced by some small foramina, opening into canals, for the transmission of the superior dental nerves. Between the superior border of this bone, and the great ala of the sphenoid, is a fissure (*spheno-maxillary*), which is directed forwards and outwards, and communicates with the orbit; and between its posterior border and the pterygoid process is another (*pterygo-maxillary*), whose direction is vertical. The angle formed by the union of these fissures constitutes the *spheno-maxillary fossa*, which is situated before the base of the pterygoid process, behind the summit, or posterior termination, of the orbit, and immediately external to the nasal fossæ, from which it is separated by the perpendicular plate of the palate bone. Into this narrow spot five foramina open, viz. the foramen rotundum, which gives passage to the second branch of the fifth pair; the foramen pterygoideum, to the Vidian or pterygoid nerve and artery; the pterygo-palatine, to a small artery of the same name (sometimes called also the superior pharyngeal); the posterior palatine foramen, leading to the canal of the same name; and the spheno-palatine, which transmits the spheno-palatine nerve and artery.

169. The *internal surface* of the skull may be divided into its arch and its base. The arch extends from the base of the perpendicular part of the frontal bone, as far as the transverse ridge on the inner surface of the occipital bone. Along the middle line, and corresponding with the direction of the sagittal suture, is a shallow groove, marking the course of the superior longitudinal sinus. Several slight irregular depressions may also be observed, for the cerebral convolutions, and some tortuous lines for the branches of the meningeal artery; and in many cases irregular depressions over the points occupied by glandulæ Pacchioni. The surface is more or less depressed so as to form fossæ at the points corresponding with the frontal and parietal eminences, and also above the internal occipital ridge, where the posterior lobes of the brain are lodged.

170. The *base* of the skull presents the several eminences, depres-

sions, and foramina, which have been already enumerated in the description of the separate bones. Three fossæ may be observed at each side, differing in size and depth.

The *anterior fossa,* formed by the orbital plate of the frontal bone and the smaller wing of the sphenoid, serves to support the anterior lobe of the brain: it is marked by eminences and depressions corresponding with the cerebral convolutions and sulci; and, posteriorly, by a transverse line, indicating the junction of the bones just mentioned.

The *middle fossa,* formed by the great ala of the sphenoid, the squamous part of the temporal, and the anterior surface of the pars petrosa, lodges the middle lobe of the brain. It is marked by linear impressions for the meningeal artery, and by shallow pits for the cerebral convolutions; anteriorly it opens into the orbit by the sphenoidal fissure, sometimes called foramen lacerum anterius to distinguish it from those placed farther back, and already noticed; it transmits the third, the fourth, and the sixth nerves, together with the ophthalmic branch of the fifth and the ophthalmic vein. Behind this is situated the foramen rotundum for the second branch of the fifth, the foramen ovale for the third, and, lastly, the foramen spinosum for the middle meningeal artery. Where the summit of the pars petrosa approaches the body of the sphenoid bone, there the internal orifice of the carotid canal opens. On the anterior surface of the pars petrosa, and directed obliquely backwards, there is a slight groove, leading to the hiatus Fallopii, and transmitting the Vidian nerve.

The *posterior fossa,* deeper and broader than the others, gives lodgment to the lateral lobes of the cerebellum. In the posterior surface of the pars petrosa, which forms the boundary of this fossa, may be observed the internal auditory foramen, and, within a few lines of it, a triangular fissure, which opens into the aquæductus vestibuli, and towards its inferior margin part of the groove for the lateral sinus, which leads down to the foramen lacerum posterius. Along the middle line, and taking the parts situated in the base of the skull from before backwards, we observe the crista galli of the ethmoid bone, and on each side the cribriform lamella of that bone; farther back, a slightly depressed surface, which supports the commissure of the optic nerves; and on each side the optic foramina. Behind this is the pituitary fossa, situated on the body of the sphenoid bone, bounded before and behind by the clinoid processes. Leading downwards and backwards from these is the basilar groove, which supports the pons Varolii and medulla oblongata, and terminates at the foramen magnum: at each side of this foramen are the condyloid foramina, and behind it a crista, leading upwards to the occipital ridge, and giving attachment to the falx cerebelli.

The Orbits.

171. The form of the orbits is that of a quadrilateral pyramid, whose base is directed forwards and outwards, and apex backwards and inwards, so that if their axes were prolonged backwards they would decussate on the body of the sphenoid bone.

The *roof* of each orbit forms part of the floor for the brain; it is concave, and composed of the orbital process of the frontal, and the smaller wing of the sphenoid bone: at its anterior and inner border may be observed a depression for the attachment of the pulley of the trochlearis muscle; externally, and immediately within the margin of the orbit, a shallow depression for the lachrymal gland; at the anterior border, a groove, sometimes a foramen, which transmits the supra-orbital or frontal nerve and artery; and posteriorly, at the apex of the cavity, the optic foramen, transmitting the optic nerve and ophthalmic artery. The *floor* forms the roof of the maxillary sinus: it consists of the orbital processes of the malar and maxillary bones, and of the small portion of the palate bone which rests on the latter; towards the inner and anterior border, near the lachrymal canal, may be observed a slight roughness, for the attachment of the obliquus inferior muscle; posteriorly, a groove, terminating in the infra-orbital canal, which runs nearly horizontally forwards. The *inner side* or wall of the orbit runs directly backwards, being parallel with the corresponding side of the other orbit, and is composed of the ascending process of the maxillary bone, the os unguis, the os planum of the ethmoid, and part of the body of the sphenoid bone. Near the anterior border is situated the *lachrymal canal,* which is formed, for the most part, between the ascending process and body of the maxillary bone, the remainder being made up by the groove in the os unguis, and a small process of the inferior spongy bone; this canal, a little expanded at its extremities, is directed downwards, backwards, and a little outwards. The *outer* side of the orbit, composed of the orbital plates of the malar and sphenoid bones, presents some minute foramina, which transmit small nerves from the orbit to the temporal fossa.

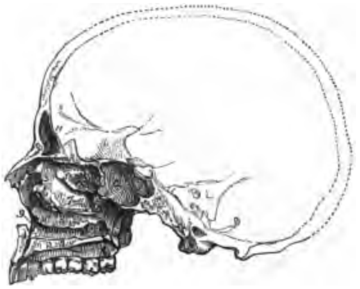
The *superior internal angle,* formed by the junction of the orbital process of the frontal bone with the os unguis and os planum, presents two foramina (*foramen orbitale internum, anterius, et posterius*), which give transmission, the anterior to the nasal twig of the ophthalmic nerve, the posterior to the ethmoidal artery. The *internal inferior angle* is rounded off so as to be scarcely recognised; it is formed by the union of the os unguis and os planum with the orbital plates of the superior maxillary and palate bones. In the *external superior angle,* formed by the malar, frontal, and sphenoid bones, is observed the sphenoidal fissure, of a triangular form, situated obliquely, its base being internal and inferior, the apex external and superior. In the *inferior external angle,* formed by the malar, the great ala of the sphenoid, the maxillary, and palate bones, is situated the spheno-maxillary fissure, inclined at an angle with the former, and communicating with it, but of a different form, being broad at its extremities, and narrow at the centre.

172. The *anterior extremity,* or *base,* of the orbit, is directed outwards and forwards; and, as if to provide for a free range of lateral vision, the external wall retreats in some degree, and does not extend as far forward as the internal. The inner termination of the cavity, representing the summit of a pyramid, to which it has been likened, corresponds with the optic foramen. In each orbit, parts of seven bones are observed, viz. the frontal, ethmoid, sphenoid, os unguis, malar, maxillary, and palate bones; but as three of these, viz. the ethmoid, sphenoid, and frontal, are common to both, there are only eleven bones for the two orbits.

The Nasal Fossæ.

173. These fossæ, fig. 51, are two cavities, placed one at each side of the median line, separated by a flat vertical septum. They communicate, by foramina, with the various sinuses lodged in the frontal, the ethmoid, and superior maxillary bones, and open anteriorly, on the surface, by the nares, and posteriorly into the pharynx. The roof, the floor, the inner and the outer walls of these cavities, require a separate consideration.

Fig. 51.



The *roof* is flat at its middle part, and sloped before and behind it; is formed in front by the inner surface of the nasal bones, 1, behind by the body of the sphenoid, 12, and in the middle by the horizontal or cribriform lamella of the ethmoid bone, 2. The *floor*, smooth, concave from side to side, and formed by the palate plates of the maxillary and palate bones, 3, extends backwards, and a little downwards, from the nares to the pharynx. Towards the anterior opening may be observed the superior orifice of the anterior palatine canal, 4. The *internal wall*, or septum narium, which extends from the roof to the floor of the cavity, is flat, nearly vertical (the deviation, if any, being usually to the left side), and composed of the perpendicular plate of the ethmoid bone, the vomer, and the nasal cartilage. The *external wall* is formed by the ethmoid, superior maxillary, os unguis, inferior spongy, and palate bones. The posterior and inferior parts of this surface are marked by a number of inequalities, whilst the superior and anterior are comparatively even. In the latter situation may be observed, first, the smooth surface just mentioned; and, secondly, passing downwards and backwards, three, and frequently four, arched and convoluted bones (spongy bones), beneath which are grooves (*meatus*) leading from before backwards. The superior spongy bone, 5, is much shorter than the others; beneath it is the *superior meatus*, 6, into which will be found opening, anteriorly, a foramen from the posterior ethmoidal cells, and, posteriorly, the spheno-palatine foramen. The middle spongy bone, 7, overhangs the *middle meatus*, 8, which communicates with the anterior ethmoidal cells; one of these, curves forwards and upwards, and is continuous with the frontal sinus; more posteriorly is situated the opening of the maxillary sinus. The *inferior meatus*, 9, situated below the inferior spongy bone, 10, between it and the floor of the nasal cavity, is necessarily longer than the others; it presents anteriorly the orifice of the nasal canal.

The Frontal, Sphenoidal, and Maxillary Sinuses.

174. The *frontal sinuses*, fig. 51, 11, correspond with the superciliary eminences of the frontal bone. Of considerable size in the adult, but varying in different individuals, they are not at all developed in the fœtus. They are divided into two, sometimes three, compartments.

175. The *sphenoidal sinuses*, 12, two in number, are placed within the body of the sphenoid bone; these also cannot be said to exist in infancy. They are separated by a partition. Above, behind, and on each side, they are bounded by the body of the sphenoid bone, and in front by two small spongy bones (cornua sphenoidalia).

176. The *maxillary sinus* (antrum Highmori) is a large excavation in the body of the superior maxillary bone. It appears at an

earlier period than any of the other sinuses, the developement commencing about the fourth month of fœtal life. Its form is irregularly pyramidal, the base being towards the nasal cavity, the apex corresponding with the malar tuberosity. Superiorly, it is enclosed by the orbital plate of the maxillary bone; and inferiorly by its palate plate: internally, it opens into the middle meatus of the nasal cavity by a foramen, which, though it appears very large in the dry bone when separated from its connexions, is in the natural state small, being little more than sufficient for the admission of a probe; this diminution of size is caused by the lower edge of the ethmoid, the inferior spongy and the palate bones, and also by a fold of the mucous membrane.

Analogy between Cranial Bones and Vertebræ.

177. Anatomists have at all times perceived and recognised the analogy between the movable and motionless pieces of the spine—between those of the lumbar and dorsal regions, and those of the sacrum and coccyx: in the one, as well as in the other, similar organic elements are observed to exist, variously modified, in order to suit special purposes; but it is only of late years that any adequate attention has been directed to the points of similitude which exist between vertebræ, properly so called, and the cranial bones. Many persons who adopt, without hesitation, the terms false or pelvic vertebræ, as applied to the sacrum and coccyx, feel a repugnance to use the word false or cranial, as applied to the pieces of the skull; and deny, perhaps without examination, the analogy upon which it is founded, as being unnatural or far-fetched. We have numerous instances of the harmony that subsists between containing and contained parts throughout the economy; in no case is it more striking than in the relation that obtains between the fundamental part of the osseous structure and the central mass of the nervous system. The spinal canal is accurately adapted in its different parts to the nervous cord which it encloses. In the pelvic region, the canal, at least in the human subject, becomes narrow, as it merely encloses nerves, whilst the body and processes take on a particular developement to meet a special purpose, that of forming a basis of support for the rest of the column. This seems to result from the working of what may be termed a principle of compensation in the growth, as well as in the action of parts; for when one part of a given whole is developed to excess or to a maximum, others will remain at a minimum or atrophied: thus the spinal canal and the arches are at their minimum in the sacrum and coccyx, for the contained parts are there at a low point of developement; but at the

opposite end of the column the reverse obtains; the contained parts, viz. the central parts of the nervous system, are evolved in the human subject to the greatest extent, and so must the containing parts also be. The portion of the osseous system which corresponds with the bodies of the vertebræ can, therefore, hardly be recognised; whilst that which is analogous to the arches is expanded so much as to retain but a slight similitude to them.

If we take the occipital bone, and examine it attentively, we shall readily perceive in it all the elements of a vertebra. The foramen magnum is the counterpart of the ring of a vertebra, and has a similar relation to the spinal cord; the basilar process represents the body; the condyles are true articulating processes; the rough surfaces external to them, and which give attachment to the recti laterales, correspond to the transverse processes; the vertical ridge extended backwards along the median line, from the foramen to the occipital protuberance, is, in the human subject, merely a rudiment of a spinal process; but in the dog, bear, and badger, it forms a sharp prominence well deserving the name of spine, and the likeness is still more striking in osseous fishes: finally, the broad plates on each side of the spine represent the arches. In this view of the matter, the occipital bone forms the first false vertebra of the cranial region.

In the second cranial piece or vertebra, it must be admitted that the analogies are not so striking; but when we recollect that the cavity of the skull, if examined in the different orders of animals, enlarges in proportion as the brain acquires an increase of developement, and that this enlargement attains its maximum in the human subject, we shall at once find sufficient reason to expect that the parts corresponding with the vertebral arches should, in this region, be greatly evolved, while the rest are in a manner atrophied. The parietal bones, with the squamous part of the temporal and the great wings of the sphenoid, taken together, represent the arches, whilst the posterior part of the sphenoid bone (such as it exists in the human fœtus before its ossification is complete, and such as it continues permanently in several lower animals,) is the counterpart of the body; the mastoid processes of the temporal bones with the glenoid fossæ serve as transverse and articulating processes. These, together, form the middle cranial piece, which may be termed the spheno-temporo-parietal cranial false vertebra.

The frontal bone, the ethmoid, and the anterior division of the sphenoid (which is that part of the body that sustains the smaller wings), form the third vertebra; the part of the sphenoid just named, together with the crista galli and the perpendicular plate of the ethmoid bone, form the body, which is here reduced to a rudimentary state, just as the coccygeal bones are at the opposite end of the column, of which it may be considered a repetition. The lateral and expanded parts of the frontal bone are the arches, and the external orbital processes may be likened to transverse processes.

We have here used the term false vertebra as applied to the cranial pieces; perhaps it would be better to use the word zone, as sanctioned by the authority of Cuvier. The passage in which he recognises the principle of developement here indicated, as well as the application of it, (which appears to have been first inculcated by Dumeril, and traced in all its details by Geoffroy Saint-Hilaire,) is as follows:—"Le crâne se subdivise comme en trois ceintures, formées—l'antérieure par les deux frontaux et l'éthmoide, l'intermédiaire par les pariétaux et le sphénoide, la postérieure par l'occipital." *

Man adapted to the erect posture.

178. Every part of the conformation of the human subject indicates its adaptation to the erect position. The feet are broader than those of any other animal proportionally to its size; the tarsal and metatarsal bones admit of very little motion; and the great toe is on the same plane with the others, and cannot be brought into opposition with them. The foot is thus fitted to sustain the weight of the body, but not to grasp or seize objects presented to it. The hands, on the contrary, though so well adapted for these purposes, are ill calculated for affording support; so that man is truly "bimanous" and "biped."† The tibia rests perpendicularly on the astragalus, and the os calcis projects backwards for the purpose of increasing the base, and also of lengthening the lever to which the strong muscles of the calf of the leg are attached. The whole extent of the tarsus, metatarsus, and phalanges, in man, rests on the ground, which does not obtain even in apes, the end of whose os calcis is somewhat raised, so as to form an acute angle with the bones of the leg. In dogs and digitated quadrupeds, the carpus and tarsus are considerably elevated from the ground, so that the body rests on the toes; and in the horse, and other solid-hooved animals, the third phalanges only rest on the ground, the os calcis being raised nearly to the perpendicular direction.

The femur, placed securely beneath the pelvis, affords a firm support during progression. The great breadth of the pelvis serves to enlarge the base on which the trunk rests; and this is farther increased by the length of the cervix femoris. This peculiarity in the neck of the femur renders it necessary that the body of the bone should incline inwards, in order that its axis should approach the central line, and so support the centre of gravity. If its articular head be viewed in profile, it will be observed that the cartilaginous coating is distributed for the most part on its upper and inner aspect, showing its adaptation as a pillar of support in the erect position.

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* Règne Animal, tom. i. p. 63.

† Règne Animal, tom. i. p. 82.

The bones of the pelvis in the human subject are distinguished from those of other animals by some marked peculiarities. The sacrum is remarkably broad and expanded, so as to form a firm support for the spinal column which rests upon it; its lower part is curved and articulated with the coccyx, so that both incline forwards and enclose the pelvic cavity, constituting a support for the viscera when pressed down by muscular action. If a different arrangement of these bones obtained—if they were continued downwards in a straight line, they would project beyond the ischia and render the sitting posture irksome or impossible.

The spinal column, which is supported on the pelvis, is peculiarly adapted to the erect attitude. Its pyramidal form and enlarged base fit it to sustain the superincumbent weight; and by means of the different curvatures which it presents, a considerable range of motion is allowed to the trunk, the centre of gravity being still supported within the base. The form of the thorax is also peculiar. Shallow and compressed from before backwards, it is broad and expanded from side to side; by which means the preponderance of the trunk forwards is considerably lessened. The sternum, though broad, is very short, so that a considerable space intervenes between it and the pubes, which is occupied solely by muscular parts. But in quadrupeds, the thorax is compressed and flattened laterally, becoming gradually narrower towards the sternum, which is prominent and keel-shaped, so that the breadth from this latter bone to the spine is much greater than that from side to side. This conformation, together with the absence of clavicles in true quadrupeds, enables the anterior extremities to approach closely together, and fall perpendicularly downwards beneath the trunk, so as to give it a steady support. The sternum is elongated in these animals, and the ribs pass from the spine to that bone so directly, without making any angle, that they approach near to the crista of the ilia, and thereby increase the extent of firm support necessary to sustain the weight of the viscera. Even with these advantages, the muscles of the abdomen would be inadequate to the support of its contents, were they not assisted by a layer of elastic substance, which is placed over their entire extent, and which of itself marks their destination for the prone position.

Though the upper and lower extremities present several points of similitude, they yet may be contrasted so as to show that they are adapted to totally different purposes. It is quite obvious that the scapula and os innominatum, the humerus and the femur, the bones of the fore-arm and those of the leg, the hand and the foot, are respectively constructed on the same plan; but the differences which they present indicate a difference of function.

The scapulæ, placed on the supero-posterior part of the trunk, are borne off by the clavicles; their glenoid cavities are directed forwards and outwards, so that the arms, which are, as it were, appended to them, are fitted to enjoy a considerable degree of motion in the anterior and lateral directions. But in true quadrupeds the glenoid cavities look downwards, and are approximated closely together, so that the thoracic limbs, which are articulated with them, descend beneath the fore part of the trunk; and, as they are thus calculated to support its weight, they possess little lateral motion. The glenoid cavity in man is quite shallow, so that the globular head of the humerus is merely applied to its surface; but the acetabulum is a deep cup-like cavity, indicating a quite different destination in the two joints. The breadth of the articular surfaces of the knee-joint, and the peculiar conformation of the ankle-joint, as contrasted with the elbow and wrist, are abundantly sufficient to show that fixity and strength have been designed in the one, mobility in the other. This difference is, if possible, more strongly marked in the conformation of the hand and foot: the latter, as has been already observed, being intended to support the body, is placed at right angles beneath the leg; the former is continuous with the line of direction of the fore-arm, otherwise it could not be guided with sufficient precision to the different objects which it is intended to seize. The tarsal bones are large, firm, and strong; those of the metatarsus are also thick and large, and placed all in a line. That which supports the great toe being the stoutest of all, and almost immovable, ranges with the others. But the metacarpal bones are quite differently disposed; that which supports the thumb admits of considerable motion in every direction, so as to perform a complete circumduction, and is placed so much out of line with the others that it can be opposed to them, as in grasping different objects. The hand and foot may be considered as divisible each into two parts, differing in their degrees of mobility, viz. the digital phalanges, and the row of bones which sustains them. The movable phalanges of the hand are as long as the carpal and metacarpal bones taken together; but in the foot, they are not a third of the length of the tarsal and metatarsal bones.

179. No part of the osseous system of man affords more striking evidence of his adaptation for the erect posture than the cranium. Resting on the summit of the vertebral column, the line of its base forms a right angle with that of the column itself, which thus affords it a firm support. The condyles, or points of articulation, are situated very near the centre of its base, being, however, a little nearer to the occipital protuberance than to the anterior surface of the jaws; by this arrangement, very little active power is required to maintain it *in equilibrio.*[*] In other animals the condyles are placed much further back; so that, instead of resting on the column, the skull is, as it were, appended to its extremity, and is sustained by an elastic substance, (ligamentum nuchæ,) which is attached by one extremity to the spinous processes of the vertebræ, and by the other to the occipital protuberance. The head, as has been already observed, is composed of two parts, the cranium and face; the one being intended to contain the brain—the material instrument of the mind; the other to enclose the organs of sight, smell, and taste. The more the organs of smell and taste are developed, the greater is the size of the face, and the greater its relative proportion to the cranium. On the contrary, the larger the brain, the greater must be the capacity of the skull, and the greater its proportion to the face. On this principle, a large cranium and a small face indicate a large brain with a restricted developement of the sense of smell and taste; but a small cranium and a large face mark an opposite conformation. The character and nature of animals is determined by the degree of energy with which their different functions are performed; they are guided and impelled by some leading propensity or disposition; and as the cranium and face bear to the brain and organs of sense the relation of containing and contained parts, the study of their relative proportions is one of great interest to the naturalist, inasmuch as they serve as indices of the faculties, instincts, and capabilities of different individuals, as well as of classes.

180. Several methods have been suggested for determining the proportion of the cranium to the face; the simplest is that of Camper. If a line be drawn upwards from the side of the chin, over the most prominent part of the forehead, it will form an angle with a horizon-

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[*] Lawrence on the Characters of the Human Head, passim.

tal line drawn backwards over the external auditory foramen from the margin of the anterior nares; the size of the angle will indicate the degree of developement of the cranium and brain, as compared with that of the face and organs of sense. In the crocodile these lines are so nearly coincident, that there is scarcely any appreciable angle.

In the Horse it measures*	23°
Ram	30
Dog	35
Ouran-outang	56 to 60
European adult	85

Thus we find man at the top of the scale of animated beings, distinguished from all the rest, as well by his external conformation as by his internal organisation. When the mind has passed in review the many links of the chain which connects the lowest with the highest—the mere animated dot, with man, the lord of the creation, it cannot fail to be struck with astonishment at the immense chasm which separates them. Yet, when each link of the chain is compared with that which precedes and follows it, the transition from the one to the other is found to be so gradual as to be almost imperceptible. So easy are the steps of ascent from the organisation of the higher orders of the quadrumana, up to the human species, that even Linnæus felt it difficult to assign the specific characters by which man is distinguishable from all others; but any doubt that may have existed on this subject has been long since removed. The physical and moral attributes of man are universally recognised as sufficient to elevate him much further from the higher mammalia than these are from the classes beneath them; and in the opinion of Cuvier,† he should be considered not merely as a distinct species, but even as forming a separate order by himself. Whether, then, with the zoologist, we consider the physical conformation of man as compared with that of other animals, or, with the moralist, reflect on his mental powers and high destination, we can scarcely refrain from saying, with the poet,

> Sanctius his animal mentisque capacius altæ
> Deerat adhuc, et quod dominari in cætera possit,
> Natus est homo.

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* Cuvier, Leçons d'Anatomie Comparée, tom. ii. p. 8.

† Règne Animal, tom. i. p. 81.

THE TEETH.

181. The adult human subject is furnished with thirty-two teeth, sixteen in each jaw, arranged so that eight are placed on each side of the symphysis, in the upper and lower maxillæ. To facilitate their description, it is usual to consider a tooth as divisible into its *crown*, or that part projecting externally; the *root*, or that contained within the alveolus; and the *neck*, or part intermediate between the two. The root and central part of each tooth are composed of dense and hard osseous matter; and the projecting part, or crown, is, moreover, encased by a layer of white and excessively hard laminated substance, called enamel; at the superior and lateral parts of the crown the layer of enamel deposited upon it is thick, but gradually becomes thin at the neck, and disappears at the commencement of the root. The root and body of each tooth present a cavity, lined by a membrane (pulpa dentis), on which the nutritious vessels and nerves ramify, after having entered through the foramina in the apices of the roots.

The teeth differ in size, form, manner of insertion, and mode of action, so that they are divisible into four sets, each of which has received a particular denomination, viz. incisores, cuspidati, bicuspidati, and molares.

182. The *incisor*, or cutting teeth, (dentes incisores,) four in number in each jaw, are placed at the fore part of the mouth, forming the convex prominent part of the dental arch; their projecting part is wedge-shaped, the anterior and posterior surfaces being compressed, so that their free border is thin and sharp; this part of the tooth is convex in front, flat or concave behind, where it slopes upwards and forwards from a small elevation, which surmounts the neck. Those in the upper jaw, particularly the central pair, are larger than those of the lower. The roots of all are single, elongated, and tapering: the inserted as well as the projecting part of an incisor tooth is wedge-shaped, the former being compressed from side to side, the latter from before backwards.

183. The *canine* teeth (dentes cuspidati, canini) are two in number in each jaw, and come next in order after the lateral incisors. In these the projecting part is convex anteriorly, concave and sloping behind, and tapers towards its summit, where it ends in a blunted point: the root is longer and sinks deeper

into the alveolus than that of any other teeth; it is single, conical, compressed at the sides, and marked by a slight groove, running its whole length from its apex to its summit. This is a trace or a rudiment of that division into processes which obtains in the molar teeth.

184. The *small molar*, or bicuspid teeth, (dentes bicuspidati,) four in number in each jaw, are so named from usually having a divided root. They are intermediate in size as well as in situation between the cuspidati and molares. Their crown, compressed laterally where it is in apposition with the other teeth, is rounded on the external and internal sides, so that its depth from without inwards is greater than that of the incisores or cuspidati, whilst its breadth from side to side is less. The cutting extremities present two tubercles, one internal, the other external; in the lower jaw the internal tubercle is but very slightly prominent. A section of the neck presents an oval form, the root is single till near the apex, where it is usually bifid, particularly in the posterior bicuspidati; the groove at its sides is deeper than in the cuspidati.

185. The *large molar*, or true grinding teeth, (dentes molares,) are larger and placed farther back than the others; the crown, or projecting part, is compressed from before backwards, as well as at the sides, so as to assume a cuboid form; its free surface, which is intended for trituration, is surmounted by four tubercles, separated by depressions, which so intersect one another as generally to assume a crucial form. There are six molares in each jaw when the set is completed: the first and second are the largest of all the teeth, and in the upper jaw are usually furnished with three roots, very seldom with four, whilst in the lower jaw there are but two. The disposition of the roots deserves attention. In the upper jaw two of the roots are placed external, and parallel in their direction, whilst the third projects inwards from them at a slight angle; in the lower jaw the roots are placed one anterior, the other posterior. The last of these molar teeth are the smallest, and, as they appear at an advanced period of life, are named *dentes sapientiæ*. The root is often single and tapering, but marked by two grooves, indicating, as it were, a tendency to separation; in the upper jaw we frequently find it bifid, with traces of a still further subdivision.

The dental formula for the adult is as follows:—incisors $\frac{4}{4}$, canine $\frac{2}{2}$, bicuspidati $\frac{4}{4}$, molares $\frac{6}{6}$.

What has been here stated applies altogether to the permanent teeth. The temporary or deciduous teeth which precede them are fewer in number, being twenty in all when complete; they are also smaller, and more delicate in their texture.

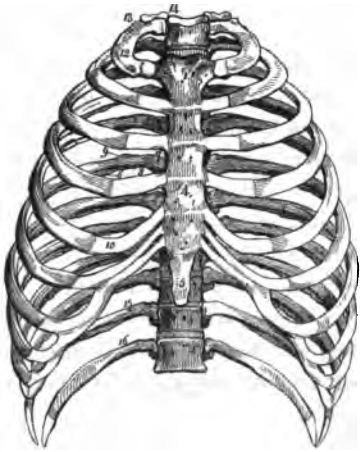
The formula for these is thus expressed:—incisors $\frac{4}{4}$, canine $\frac{2}{2}$, molares $\frac{4}{4}$.

The incisores and cuspidati are supplanted by permanent teeth of the same name: the bicuspid, which do not previously make their appearance, occupy the place of the temporary molares, so that the permanent molares will necessarily protrude at points farther back. The sockets into which the teeth are inserted are called alveoli; their form, number, and size, being determined by that of the roots, which they lodge and receive; the alveolus being divided into two or three pits when the insertion of the tooth requires it, and being but a simple tapering fossa when a simple conformation obtains. The texture of the bone along the alveolar arches is porous and open, particularly in the transverse plates which separate the alveoli. In the natural state, each of these cavities is lined by a prolongation of the periosteum, which invests the maxillary bones, and which extends into them as far as their apices, where it is reflected on the roots of the teeth so as to form a special investment for them.

THE THORAX.

186. Into the composition of the thoracic portion of the skeleton, fig. 52, enter the sternum and ribs, which are proper

Fig. 52.



and peculiar to it, and the vertebræ, which are common to it and other parts. The latter have been already described, Sect. 103—110.

THE STERNUM AND ENSIFORM CARTILAGE.

187. The sternum is situated in the median line, at the fore part of the thorax, 1, 4: it is flat and narrow, but not of equal width in its entire extent, being broad at its upper part, then narrowed somewhat, after which it widens a little; finally it becomes compressed and narrow where it joins the ensiform cartilage. Its direction is oblique from above downwards and forwards; which, together with the curve backwards in the dorsal part of the vertebral column, causes a considerable increase in the antero-posterior diameter of the thorax inferiorly. We have to consider successively its surfaces, extremities, and borders.

The anterior surface, slightly convex, and subjacent to the skin, gives attachment to the aponeurosis of the pectoralis major and to the sterno-mastoid muscles, and is marked by four transverse lines, indicating its original division into five pieces. The union between the first and second of these pieces (corresponding with the insertion of the second costal cartilages) is frequently cartilaginous even in adult age.

The posterior surface looks backwards, towards the cavity of the thorax, and gives attachment, superiorly, to the sterno-hyoideus and sterno-thyroideus muscles; inferiorly, to the triangularis sterni. Along the middle line it corresponds with the interval left by the divergence of the two pleuræ (anterior mediastinum).

The borders are thick, and marked on each side by seven angular depressions for the reception of the cartilages of the true ribs, which give them a notched or serrated appearance.

The superior extremity, broad and thick, is slightly excavated from side to side, and presents at each corner a depression for the reception of the sternal end of the clavicle.

188. The sternum, in early infancy, is divided into several pieces, but in adult age two only remain distinct. The first division of the sternum, 1, is larger and thicker than the other; its form is nearly square; its lateral margins, thin and oblique, present each an oblong depression, 2, which receives the cartilage of the first rib; and at each inferior angle may be observed

an articular half notch, which articulates with the second rib. The superior border is hollowed, and at the angles which bound it are the fossæ, 3, which articulate with the clavicles, as has been already stated; the inferior is straight, and united to the extremity of the second piece.

The second piece, 4, much longer than the first, is marked on its anterior surface by some transverse lines, which indicate its original division into separate portions. Both surfaces are nearly flat. The upper border is narrow, corresponding in breadth with the termination of the first bone, with which it is connected by cartilage. The lateral margins present each five notches for the reception of the cartilages of the five lower true ribs, and a half notch superiorly, which, with a similar depression in the first piece, forms a cavity for the second costal cartilage. The five inferior notches approach one another more closely in proportion as they are situated lower down, and part of the last is occasionally made up by the ensiform cartilage.

189. The inferior extremity of the sternum, thin and elongated, gives attachment to a cartilaginous appendix, 5, called the *ensiform* or *xiphoid* (ξιφος, a sword; ειδος) cartilage, which in most cases remains in the cartilaginous state until an advanced period of life. It is sometimes bent forwards, sometimes in the opposite direction, and sometimes pierced by a hole at its centre. Its form varies considerably in different individuals: it gives attachment to the aponeuroses of the abdominal muscles.

Articulations.—This bone articulates by its sides with the true ribs,—by its upper angles with the clavicles, and by its lower end with the ensiform cartilage. When examined at an early period, it exhibits usually eight or nine ossific centres. When sawed across, the sternum presents a considerable quantity of loose spongy texture in its interior, with a very thin lamella of compact tissue on its outside;—hence it is very light.

THE RIBS AND THEIR CARTILAGES.

190. The *ribs* (costæ) extend from the dorsal portion of the vertebral column to the sternum, forming arches, which enclose the lateral parts of the thorax. They are twelve in number at each side, of which the seven superior pairs, which are united by means of cartilaginous prolongations to the sternum, are called *sternal* or *true ribs;* the remaining five, which are not

prolonged to the sternum, being denominated *asternal* or *false ribs.*

The ribs do not arch uniformly from the vertebral column towards the sternum: the greater number consist of parts of two circles or arches of different diameters, the anterior being much the larger. Thus the rib, directed at first backwards from its connexion with the bodies of the vertebræ, reaches and is supported by the transverse process (which in the dorsal region is inclined backwards); after leaving the extremity of this process it turns abruptly outwards, and finally is directed forward towards the sternum.

In their length, breadth, and direction, these bones present several varieties. From the first to the eighth their length successively increases, whilst from the ninth to the twelfth they gradually decrease, so that the last is very little longer than the first.

Their breadth, considered in the whole series, diminishes gradually from the first to the twelfth; but in each rib it is greatest towards its sternal extremity.

As to their direction in reference to the vertebral column, the first forms almost a right angle with it, and the succeeding ones gradually incline downwards, so that their anterior extremity is lower than the posterior. The body of all the ribs, except the first, is, as it were, twisted on itself, so that their two extremities cannot be made to rest at the same time on a plain surface.

These bones present two surfaces, two borders, and two extremities.

The external surface is convex and smooth. The internal is concave, and corresponds with the pleura.

The superior border, smooth and rounded, gives attachment to the intercostal muscles; the inferior is marked on its inner aspect by a groove, fig. 52, 6, which is commonly said to be for the lodgment of the intercostal vessels, and also gives attachment to the intercostal muscles.

The posterior extremity, 7, somewhat rounded and thicker than the other parts of the rib, and hence denominated its *head*, presents (except in the instances to be presently stated) two articular faces (separated by a slight ridge) which articulate with the corresponding small surfaces on the bodies of the dorsal vertebræ; the head is supported by a narrow round part, 8, or *neck*, terminated externally by a tubercle, 9, which is smooth in one part for its articulation with the transverse process of the lower of the two vertebræ to which the head is connected, and rough in the other for the insertion of the posterior costo-transverse ligament.

The anterior extremity is broad, flat, and hollowed at its tip into an oval pit, into which is implanted the costal cartilage.

Between the tuberosity and the most convex part of the body of each rib is a rough line, marking what is termed its *angle*. The distance of the angle from the tuberosity increases gradually from the second to the eleventh inclusive. In the last it is not perceptible: in the first it is not distinguishable from the tuberosity.

The first two and the last two ribs present some peculiarities deserving of notice.

191. The *first* rib, 12, is shorter and broader than either of the succeeding ones, its direction is nearly horizontal; its body not being twisted, as is the case in other ribs, it lies evenly when placed on a plain surface. One surface looks upwards, and is marked by two very slight depressions (over which slide the subclavian vessels), and an intervening roughness, sometimes well marked, which indicates the attachment of the scalenus anticus muscle. The other surface looks downwards, towards the cavity of the thorax. The external border, convex and rounded, is surmounted by the tuberosity, 13; the internal is thin, and forms the margin of the superior aperture of the thorax. The anterior extremity is broad and thick; the *head*, which articulates with the first dorsal vertebra, 14, is small, presents an undivided articular surface, and is supported by a slender neck.

The *second* is longer than the first, and presents externally a prominent line for the attachment of the serratus magnus; its internal surface is somewhat grooved posteriorly.

The *eleventh*, 15, has no groove on its inferior border, nor a tubercle, as it is not articulated with the transverse process; its angle is scarcely perceptible, and the head has but one articulating surface.

The *twelfth*, 16, differs little from the preceding one, except in being shorter; it has neither angle, tubercle, nor groove, and as its anterior extremity, which is pointed, seems loose and unattached, it is called the floating rib.

The ribs grow from three osseous points, one in the body, one in the head, the third being at the tuberosity.

COSTAL CARTILAGES.

192. These cartilages (fig. 52, 10,—the numbers are omitted upon the others to avoid complexity in the drawing,) are twelve in number, like the ribs, of which they form the elastic continuation; their breadth diminishes gradually from the first to the last, whilst the length increases as far as to the seventh, after which it becomes less in each succeeding one. Their line of direction also varies considerably. The second is horizontal, the first descends a little, and all the rest ascend more and more as they are situated lower down. The external or costal extremity, convex and unequal, is implanted into the end of the corresponding rib. The internal extremities of the cartilages of the true ribs, smaller than the external, and somewhat pointed, are articulated with corresponding angular surfaces on the sides of the sternum; each of the cartilages of the first three false ribs, becoming slender towards its extremity, is attached to and blended with the lower border of that which is next above it; in the two last it is pointed, and unattached.

Attachments of muscles.—The two layers of intercostals to the contiguous borders of all the ribs; the scaleni to the first and second; the pectoralis major to the cartilages of the true ribs, except the first; pectoralis minor to the bodies of the third, fourth, and fifth; rectus abdominis to the cartilages of the last three true ribs and ensiform cartilage; obliquus externus to the last three true ribs, and all the false; the internal oblique and transversalis to the cartilages of the four or five false ribs; the diaphragm to the ensiform cartilage, and to those of the last six ribs.

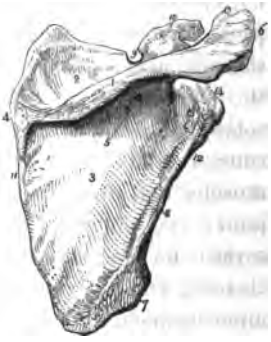
The serratus magnus to the nine superior ribs; latissimus dorsi to the four inferior; serratus posticus superior to the third, fourth, and fifth true ribs; serratus posticus inferior to the three last; sacro-lumbalis to the angles of all the ribs; levatores costarum a little beyond the tuberosities.

BONES OF THE SUPERIOR EXTREMITY.

The upper extremity consists of the shoulder, the arm, the fore-arm, and the hand. The shoulder consists of the scapula and clavicle; the arm of the humerus; the fore-arm of the radius and ulna; and the hand of the carpus, metacarpus, and fingers.

SCAPULA.

Fig. 53.



193. This bone, fig. 53, is placed upon the upper and back part of the thorax, occupies the space from the second to the seventh rib, and forms the posterior part of the shoulder.

Its form is irregularly triangular and flat. It presents for examination two surfaces, three borders, and three angles.

The anterior surface, called also *fossa subscapularis*, looks towards the ribs, is triangular, slightly concave, intersected by prominent lines, directed from within outwards and upwards, and therefore crossing the direction of the ribs.

The posterior surface (*dorsum scapulæ*) is divided into two parts, but unequally, by a prominent ridge, 1, (the spine): of these, the superior one, 2, is called fossa supra-spinata; the inferior, 3, fossa infra-spinata.

Of the spine.—The spine of the scapula is a prominent ridge of bone, flattened from above downwards, commencing at the posterior border of the scapula, with a smooth flat triangular surface, 4, from which it becomes gradually more elevated as it proceeds forwards, until it terminates in an elongated process, 6, (acromion,) which surmounts the shoulder-joint. The form of the spine considered by itself apart from the acromion is triangular; hence we have to notice its two surfaces and three borders. Its superior surface is concave, and, conjointly with the superior part of the dorsum of the scapula, forms the fossa supra-spinata. The inferior surface is irregularly triangular, constitutes part of the infra-spinous fossa, and in its middle may be observed a small foramen, 5, for a nutritious vessel. On the projecting border of the spine, which is rough and broad, may be noticed two margins, of which the superior one gives attachment to the trapezius, the inferior to the deltoid muscle—the intervening edge is subcutaneous. The anterior or attached border, or base, is united with the dorsum of the bone. The external border, which is short, round, and somewhat concave, approaches the neck of the bone, and is continuous with the under surface of the acromion.

Of the acromion process.—This considerable eminence, 6, is flattened in the direction opposite to that of the spine, and, projecting outwards and forwards, forms the summit of the shoulder-joint; hence its designation, (ακρον, a summit; ωμος, the shoulder). Its posterior and upper surface, convex and somewhat rough, is subcutaneous; the anterior and inferior one, concave and smooth, is in relation with the supra-spinatus muscle, and overlays the capsular ligament of the shoulder-joint; the superior border presents, anteriorly, a narrow oval surface for its articulation with the external extremity of the clavicle, and its summit affords attachment to the coraco-acromion ligament.

194. The *fossa supra-spinata*, 2, wider towards its vertebral than the other extremity, is filled up by the supra-spinatus muscle. The *fossa infra-spinata*, 3, much larger than the preceding, is convex in the middle, somewhat concave, or rather grooved, inferiorly. Between the latter part and the axillary border is a slightly raised and elongated ridge, 8, which extends from the glenoid cavity obliquely downwards to within an inch of the posterior angle of the bone, where it subsides into a flat and nearly quadrilateral surface, 7. This latter part it is that gives origin to the teres major muscle, and over it slides the latissimus dorsi. Along the upper and rounded part arise the fibres of the teres minor; whilst the line of division between them marks the attachment of an aponeurosis, common to these muscles and to the infra-spinatus, which occupies the remainder of the fossa.

Of the three *borders* of the scapula, or costæ (as they are sometimes called), the *superior* is the shortest; at its outer part is situated a lunated notch, 9, (lunula; incisura semilunaris,) which is converted into a foramen by a ligament, and is traversed sometimes by the supra-scapular vessels and nerve, but usually by the nerve alone. In front of this opening it is surmounted by the *coracoid* process, 10, which being thick, elongated, and curved on itself, is named from some fancied resemblance to a crow's beak, (*ϰοϱαξ*, a crow; *ειδος*, like). This process, superiorly convex and unequal, gives attachment to the coraco-clavicular ligament; anteriorly to the pectoralis minor muscle; posteriorly to the coraco-acromion ligament; and by its extremity to the biceps and coraco-brachialis muscles. The *posterior*, or vertebral border, 11, named also the "base" of the scapula, is the longest of the three; superiorly it approaches to the vertebral column, inferiorly it is more removed from it. The portion of this border which is above the spine will be observed to incline a little outwards. For the purpose of more easily assigning the attachments of the several muscles which are connected with it, we may regard it, though very thin, as divisible into two margins, with an inter-space; these are stated in the enumeration of the muscular attachments. The *axillary* border is inclined downwards and backwards from the lower margin of the glenoid cavity to the inferior angle of the bone; hence it is named the *inferior costa* of the scapula. It is of considerable thickness, being surmounted posteriorly by the ridge above noticed as giving origin to the teres minor. The edge itself presents a shallow groove running along the greater part of its extent. It corresponds with the lower border of the subscapular muscle. For about an inch beneath the glenoid fossa there is a well-marked linear impression, 12, which gives origin to the long head of the triceps muscle.

The postero-superior *angle* is formed by the junction of the base with the superior costa of the scapula; it is somewhat inclined outwards. The inferior angle is placed at the union of the base with the axillary or inferior border of the bone; upon it may be observed an elongated flat surface, 7, which gives origin to the teres major, and over which slides the latissimus dorsi muscle. At the convergence of the superior and inferior borders may be observed a narrow constricted part, 13, denominated the *neck* (cervix scapulæ). The neck is bounded by a slightly raised rim, 14, which gives attachment to the fibrous capsule of the shoulder-joint; and finally the rim surrounds the articular surface of the bone which is called the *glenoid* cavity (γληνη, a superficial cavity; ειδος). This is a shallow, oval depression, broader below than above, covered with cartilage in the fresh state, and deepened somewhat by a fibro-cartilaginous margin, which passes round it from the long tendon of the biceps muscle, whose origin is at its upper margin; its greatest diameter is perpendicular, its direction outwards and forwards. In this last respect, however, it varies considerably; for during the more extended motions of the humerus, the scapula is made to turn, as it were, on a pivot driven through the centre of its dorsum, by which means the glenoid cavity is kept constantly in apposition with the head of the humerus, which is the chief security against its dislocation.

The scapula articulates by its glenoid cavity with the humerus, and by the acromion process with the clavicle; it affords attachment to the following muscles:—

The sub-scapular fossa (the anterior or costal surface of the bone) to the sub-scapularis muscle. Posterior or dorsal surface,—the spine (by its border and the acromion) superiorly to the trapezius, inferiorly to the deltoid: the fossa supra-spinata, by its posterior two-thirds, to the muscle of the same name: the fossa infra-spinata, in the greater part of its extent, to the infra-spinatus; by a slight oblique line situated near the inferior angle, to the aponeurosis common to the infra-spinatus, teres minor, and teres major; by a narrow rounded surface, near the axillary border, to the teres minor; by the flat surface, at its inferior angle, to the teres major.

The superior border, near the margin of its notch, to the omo-hyoideus; the coracoid process, anteriorly, to the pectoralis minor, by its summit to the biceps and coraco-brachialis. The posterior border or base, anteriorly, to the serratus magnus; posteriorly, to the supra-spinatus and infra-spinatus; in the inter-space to the rhomboidei and to the levator anguli scapulæ. The inferior, or axillary border, at its upper part by a rough ridge to the long portion of the triceps extensor; posteriorly, by an unequal surface, to some fibres of the teres minor; inferiorly, to the teres major.

The inferior angle to the teres major, and occasionally to some fibres of the latissimus dorsi; the anterior angle, (glenoid cavity,) by its upper margin, to the long head of the biceps muscle.

Developement.—When the scapula is examined at a very early period, it appears as a thin lamella without any elevation corresponding with the spine. Soon after an osseous centre is seen towards the middle of its dorsum, one in the coracoid process, and in the acromion. The base and the inferior angle also commence by separate points.

THE CLAVICLE.

195. The clávicle (*clavis*, a key), or, as it is popularly called, the collar-bone, is extended, transversely, between the acromion process of the scapula and the summit of the sternum, which it serves to connect; its direction, however, is not exactly horizontal, the acromial end being slightly elevated. This bone is curved somewhat like an italic *f*, the degree of the curvature being less in young and female subjects than in male adults; it is rather thick and somewhat triangular towards its sternal end, but broad and flat towards the scapular extremity; it presents for our consideration a body and two extremities. The superior surface of the body is principally subcutaneous. The inferior surface presents, near the sternal extremity, inequalities for the attachment of the costo-clavicular ligament; in the centre, a longitudinal depression, giving attachment to the subclavius muscle, the foramen for the entrance of the medullary vessels, and, more externally, a rough oblique line, to which the coraco-clavicular ligaments are attached; this surface corresponds internally to the first rib, externally to the coracoid process and the shoulder-joint, and in the middle to the axillary vessels and brachial plexus of nerves. The anterior border is broad and convex towards the sternal, thin and concave towards the scapular extremity; the posterior border presents, of course, the opposite arrangement of curvatures. The internal extremity is inclined downwards and forwards; it is considerably thicker than the other parts of the bone, and terminates in a triangular unequal surface, which is convex from above downwards, concave from behind forwards; this is tipped with cartilage, and articulates with the sternum, the articular surface of which it much exceeds in size; its entire circumference gives attachment to ligaments. The external or scapular extremity, compressed and flattened, inclines a little backwards and upwards, and articulates

with the acromion by a narrow oblong surface which is covered with cartilage.

Attachments of muscles.—The clavicle gives attachment, by the superior surface of its sternal extremity, to the sterno-cleido-mastoid; the longitudinal depression on its inferior surface, to the subclavius; the anterior border, by its sternal half, to the pectoralis major; by its acromial third, to the deltoid; the posterior border, by its acromial third, to the trapezius.

Articulations.—The clavicle articulates with the sternum and the acromion process of the scapula.

Developement.—The division of the bone above indicated into body and extremities is merely technical, being intended to facilitate its description. It consists of one piece, and grows from one ossific centre.

THE HUMERUS.

196. The humerus or arm-bone, fig. 54, (os humeri,) the largest bone of the upper extremity, extends from the scapula to the bones of the fore-arm, with each of which it is articulated. Its direction is vertical, with an inclination inwards towards the lower end. Long and irregularly cylindrical in form, the humerus is divisible into a body and two extremities.

Fig. 54.

197. The *body* or shaft of the bone, 1, thick and rounded superiorly, is somewhat expanded, and triangular inferiorly. It is divided into two nearly equal surfaces by two longitudinal lines, of which one is external and anterior, 2, the other internal and posterior, 3. These lines may be considered as rising, the former from the external, the latter from the internal condyle, near to which they are well marked, but gradually subside as they proceed upwards on the body of the bone: they afford attachment to the inter-muscular aponeuroses. The external one is interrupted about the middle, 4, by an oblique depression, or groove, which runs from above downwards and marks the course of the musculo-spiral nerve and superior profunda artery; the surfaces separated by these

lines are named posterior and anterior. The *posterior* surface is round superiorly, and inclined a little inwards; in the lower part it is broad, flat, and turned rather outwards; it is covered in the entire of its extent by the triceps extensor muscle, and towards its middle may be observed a small foramen for the medullary vessels. The *anterior* surface is divided superiorly into two unequal portions by a longitudinal groove, 5, directed obliquely downwards and inwards, for about one-fourth of the length of the bone; this lodges the long tendon of the biceps muscle, and is therefore named the *bicipital* groove; its anterior margin, 6, gives attachment to the pectoralis major; the posterior, 7, to the latissimus dorsi and teres major. The portion of the anterior surface which is internal to this groove is smooth in the greater part of its extent, and presents, towards its middle, a linear elevation for the insertion of the coraco-brachialis, and lower down an oblique medullary foramen, 8; externally to the groove, and a little above the middle of the bone, may be observed a broad rough eminence, 9, for the insertion of the deltoid muscle, beneath which runs the oblique depression already noticed as corresponding to the course of the musculo-spiral nerve and the accompanying artery.

198. The *superior extremity* of the bone presents a large hemispherical eminence, 10, covered with cartilage in the fresh state, and directed backwards and inwards to the glenoid cavity of the scapula, with which it articulates; this is called the *head* of the humerus. It is bounded by a slightly depressed groove, sufficiently marked on the upper, not on the under aspect, denominated the *neck* of the bone. A little beneath, and to the outside of the head, are two eminences, which project from the ends of the shaft of the bone, and, from their relative size, are named the greater and lesser *tuberosities* (tubercula). The greater tuberosity, 12, is external and posterior in its situation, convex in its outline, and marked on its upper border by three flat surfaces for the insertion of the external rotator muscles. The smaller tuberosity, 13, rounded and more prominent than the other, gives attachment to the sub-scapularis muscle. They are separated by the bicipital groove. Towards its lower third the bone widens, and appears compressed and somewhat twisted from behind forward; its greatest diameter is transverse; it presents internally a considerable projection, 14, the *inner condyle*,

which is inclined backwards, and gives attachment to the internal lateral ligament of the elbow-joint, and to a tendon common to the greater number of the anterior muscles of the foramen. Externally is situated another smaller process, 15, (*external condyle*,) to which are attached the external lateral ligament and a tendon common to the muscles of the posterior and external surfaces of the fore-arm. Between the condyles is placed the inferior articular surface, which is inclined somewhat forwards. Proceeding in the enumeration of the parts which enter into its composition from the radial to the ulnar side, we observe a rounded eminence, 16, placed rather on the anterior surface of the bone, and articulating with a cavity observable on the superior extremity of the radius, calculated to allow of all that freedom of motion which the radius enjoys, viz. flexion and extension on the humerus, and pronation and supination by rotation on its own axis;—a slight groove or depression corresponding with the circumference of this eminence, a semicircular ridge, which is lodged in the space intervening between the radius and ulna;—a wide and deep groove which receives the prominent part of the larger sigmoid cavity of the ulna; and, lastly, a prominent ridge, which is received into the internal part of the same cavity. This prominence descends much lower than the external portion of the articular surface, and determines an obliquity in the direction of the humerus, when its lower extremity is made to rest on a plain surface. The groove, with its margins, forms a well-marked pulley-like surface, 17, on which the sigmoid cavity of the ulna moves in flexion and extension; hence it is termed the *trochlea.* At the fore part of the inferior extremity of the bone, and immediately above the trochlea, is a superficial depression, 18, which receives the coronoid process of the ulna during flexion, and posteriorly a more considerable fossa, which lodges the olecranon during the extension of the fore-arm.

A modification of the nomenclature applied to these different eminences has been proposed by Chaussier: retaining the term trochlea for the surface of articulation with the ulna, he calls that which articulates with the radius, the condyle, (it is sometimes called the *small head;*) and for the two lateral eminences of insertion, now named condyles, he substitutes the terms *epi-trochlea* and *epi-condyle.*

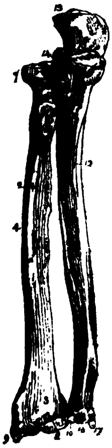
199. *Attachments of muscles.*—The posterior surface gives attachment to the triceps; the anterior (by the posterior margin of the bicipital groove) to the teres major and latissimus dorsi; in the middle, by a slightly-marked line, to the coraco-brachialis; inferiorly, to the brachialis anticus;—the external portion of the same surface, superiorly, by a rough eminence, to the deltoid; by the anterior margin of the bicipital groove, to the pectoralis major. The greater tuberosity gives attachment, by the three flat surfaces on its upper border, to the supra-spinatus, infra-spinatus, and teres minor muscles; the lesser tuberosity to the sub-scapularis. The inferior extremity, by its outer border, to the supinator radii longus, and, by its external condyle, to the extensor carpi radialis longior and brevior, extensor communis digitorum, extensor carpi ulnaris, anconeus and supinator radii brevis; by the internal condyle, to a tendon common to the pronator radii teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor digitorum sublimis.

Articulations.—The humerus articulates with the glenoid cavity of the scapula, and with the ulna and radius.

Developement.—The shaft of the bone grows from one ossific centre; the head and the two tuberosities have each their own points. So have the two condyles and the trochlea.

THE RADIUS.

Fig. 55.



200. The radius, fig. 55, 1, shorter than the ulna by the length of the olecranon process, is placed at the external side of the fore-arm, extending from the humerus to the carpus. It is broader below than above, slightly curved in its form, and divided into a body and two extremities. As the body is somewhat triangular, we observe on it three surfaces, bounded by three margins, or ridges. The *anterior* surface, 1, expands towards the lower part, and is marked along its middle by a longitudinal groove for the flexor pollicis longus; superiorly is situated the foramen, 2, for the medullary vessels, its direction being from below upwards; and inferiorly a flat surface, 3, corresponding with the pronator quadratus. The *posterior* surface, convex in the greater part of its ex-

tent, is grooved at its central third, for the origin of the extensors of the thumb; the *external* surface, round and convex, is marked towards its middle by a rough impression, 4, which gives insertion to the pronator radii teres. Of the margins separating these surfaces, the posterior is distinct only at the middle part; the external is round, and becomes smooth towards the lower extremity; whilst the internal is acute and sharp, for the attachment of the inter-osseous ligament. The body is terminated superiorly by a rough prominence, 5, (tuber radii,) termed the *bicipital tuberosity*, from its giving insertion to the biceps muscle.

Above the tuberosity the bone becomes narrowed and constricted into the form of a *neck*, which is again surmounted by the *head*, 7, intended by its extremity to articulate with the round convex part of the lower extremity of the humerus, its small head (condyle, Chauss.), while its margin rolls on the lesser sigmoid cavity of the ulna. The margin is smooth and convex; the upper surface, also smooth, is a shallow cup-like cavity; and both are covered with cartilage in the recent state.

201. The radius at its lower part becomes broad and thick; the anterior surface is flat and expanded, being covered by the pronator quadratus muscle; it is bounded below by a prominent line, 8, which gives attachment to the anterior ligament of the wrist-joint. The posterior surface is convex, and marked by grooves which transmit the tendons of the extensor muscles; of these, one which is very narrow and oblique in its direction, and nearly in the middle line, lodges the tendon of the extensor pollicis (secundi internodii). At the inner or ulnar side of this is placed another, much broader, which transmits the tendons of the extensor communis and indicator; and at its outer side, a third, divided into two parts by a linear impression, marks the passage of the flexor carpi radialis, longior and brevior. Corresponding with the external border of the bone, is another groove, directed obliquely forwards, and divided into two parts, for the tendons of the extensores—primi internodii, and ossis metacarpi pollicis. The outer side of the bone, particularly the part corresponding with the ridge which separates the two latter grooves, is prolonged downwards, and named the *styloid process*, 9; it affords attachment to the external lateral ligament of the wrist-joint. On the inner side of the bone is situated a

small cavity, 10, (semi-lunar,) covered by cartilage, which articulates with the inferior extremity of the ulna. At its inferior extremity the radius presents its carpal articulating surface, (scaphoid; navicular,) which is included between the base of the styloid process and the oval cavity just mentioned, bounded before and behind by two rough margins for the attachment of the radio-carpal ligaments. It is divided from before backwards, by a line, into two unequal portions, of which the external is triangular, and articulates with the scaphoid bone; the internal is square, and articulates with the semi-lunar.

Attachments of muscles.—The anterior surface of the body, by its grooved part, to the flexor longus pollicis; by the oblique line, leading from the tuberosity to the insertion of the pronator radii teres, to the supinator brevis and flexor sublimis; its inferior fifth to the pronator quadratus; the posterior surface, by a slight concavity in the middle, to the extensores pollicis; the external margin, by a rough surface, to the pronator teres; inferiorly, to the pronator quadratus and the supinator radii longus; whilst the posterior part of the bicipital tuberosity gives attachment to the biceps muscle.

Articulations.—The radius articulates with the humerus, the ulna, the scaphoid and semi-lunar bones.

Developement.—It has a centre of ossification for its body, and one for each extremity.

THE ULNA.

202. The ulna, fig. 55, (ωλενη, cubitus,) is placed at the inner side of the fore-arm; it is a long and rather irregular bone, larger at the upper than at the lower extremity,—a conformation the reverse of that which obtains in the radius. Its body, or shaft, is marked off into three surfaces by three prominent lines. These are all broader above than below, in consequence of the decreasing size of the bone. The anterior surface, 11, slightly depressed, is grooved longitudinally for the origin of the flexor profundus, and marked at its upper third by a foramen, 12, directed obliquely upwards for the medullary vessels. The internal surface, smooth and somewhat excavated superiorly, is covered in the greater part of its extent by the flexor profundus muscle; it becomes round inferiorly, where it is subcutaneous. The external

surface, rough and irregular, is divided into two parts, of which one, of small extent, corresponds with the superior extremity of the bone, and forms an elongated depression for the anconeus muscle; the other, reaching to the lower extremity, gives origin to the extensors of the thumb and the supinator radii brevis. Of the three margins, the internal and posterior are round, and for the most part smooth; the external is sharp, and gives attachment to the inter-osseous ligament.

203. At the superior extremity of the bone are situated two eminences, so placed as to bound the cavity by which it articulates with the humerus. Of these, one called *olecranon*, 13, (ωλενη, ulna; κϱανιον, the head,) is nearly on a line with the shaft of the bone; the other, the *coronoid process*, 14, (κοϱωνη, a crow's beak; ειδος, like,) projects from its anterior surface. The olecranon terminates in a rough tuberosity and an obtuse point; the former giving insertion to the triceps extensor; the latter being lodged, when the arm is extended, in the posterior cavity at the end of the humerus. Anteriorly, this process is smooth and hollowed out, to form part of the surface of articulation with the humerus; posteriorly, it presents a flat triangular surface, which is subcutaneous. The coronoid process, by a gentle ascent, rises upwards and forwards from the anterior surface of the bone, and terminates in a sharp ridge, which overhangs the articular surface, and is received during flexion into the anterior depression in the humerus; its anterior surface, rough and triangular, gives insertion to the brachialis anticus muscle; its upper aspect is smooth and excavated: its inner border gives attachment to the internal lateral ligament; the external is hollowed into a smooth depression, the *smaller sigmoid cavity*, which articulates with the head of the radius. The *great sigmoid cavity*, 15, formed by the junction of the smooth surfaces of these two processes, has been so named from some supposed resemblance to the form of the Greek letter Σ (σιγμα, ειδος, like), as it was originally written. Covered by cartilage in its entire extent, it is divided into two parts (but unequally, the inner one being the larger) by a smooth ridge running downwards from the peak or point of the olecranon to that of the coronoid process. This ridge and the concavities beside it correspond, the one with the groove, the others with the lateral

parts of the trochlea. At the margins of the sigmoid cavity may be observed two notches which mark off the parts of the surface which belong to the olecranon and the coronoid process respectively.

204. At the inferior extremity of the bone, which is small and rounded, are situated two eminences, of which the external one, named the *head* of the ulna, 16, round and covered with cartilage, presents two aspects, of which one, nearly circular in its form, looks towards the wrist-joint, and corresponds with the triangular fibro-cartilage of that articulation; whilst the external one, narrow and convex, is received into the semi-lunar cavity in the contiguous border of the radius. The internal eminence, 17, named the *styloid process*, projects on a line with the posterior and inner surface of the bone; it is elongated in its form, and gives attachment to the internal lateral ligament of the joint. The head and the styloid process are separated posteriorly by a groove, which is traversed by the tendon of the extensor carpi ulnaris, and inferiorly by a depression at the base of the styloid process into which the triangular fibro-cartilage is inserted.

Attachments of muscles.— The anterior surface, superiorly, and in the middle, gives attachment to the flexor digitorum profundus; inferiorly, to the pronator quadratus; the posterior surface, to the anconeus, the extensor carpi ulnaris, supinator radii brevis, the extensores pollicis, and the extensor indicis; by the posterior longitudinal line, to an aponeurosis common to the flexor carpi ulnaris, flexor digitorum profundus, and extensor carpi ulnaris. The superior extremity, by the summit of the olecranon to the triceps brachialis; the coronoid process, by its anterior rough surface, to the brachialis anticus; and by its internal side, to the second origin of the pronator teres.

Articulations.—The ulna articulates with the humerus and the radius; it has no point of contact with the carpal bones, but it is brought into relation with the cuneiform bone by means of the inter-articular fibro-cartilage.

Developement.—The shaft of the ulna, as in other long bones, has its own osseous centre; so has the lower extremity or head, as well as the olecranon process.

HAND.

The hand is composed of the carpus, meta-carpus, and fingers.

CARPUS.

205. The first or superior part of the hand is named the carpus or wrist, fig. 56; it is placed between the fore-arm and the meta-carpus, and composed of eight small bones, which are disposed in two ranges, each consisting of an equal number. Proceeding in the enumeration from the radial to the ulnar side, the bones which constitute the first or superior range are thus named from their shape—scaphoid 1, semi-lunar 2, cuneiform 3, and pisiform 4; those of the second or inferior range are the trapezium 5, trapezoid 7, os magnum 8, and unciform 9. The dorsal surface of the carpus is convex, the palmar concave and irregular, and marked by four bony prominences, across which is stretched the anterior annular ligament, so as to form a canal for the transmission of the flexor tendons.

BONES OF THE FIRST ROW.

THE SCAPHOID BONE.

206. The scaphoid or boat-shaped bone, fig. 56, 1, (*σκαφη*, a boat,) is the first of this row, and the largest. Its position is oblique, so that its broad end is directed towards the trapezium and root of the thumb, whilst the narrow one inclines inwards and upwards to the middle of the articular surface of the radius. It is convex on one side, concave on the other. The concave or hollowed surface (scaphoid) looks obliquely inwards and forwards, and is that which determines the form and gives name to the bone. Its upper articular surface, convex and triangular, is applied to the radius; the lower, also convex, articulates with the trapezium and the trapezoid bone. Its concavity receives part of

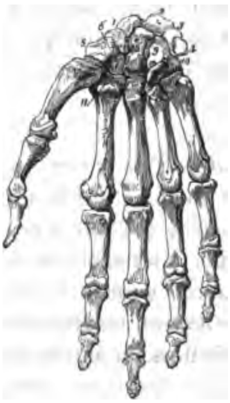


Fig. 56.

the head of the os magnum; close to this is a narrow articular surface which is in contact with the semi-lunar bone; on its radial side is a rough surface, to which is attached the external lateral ligament of the wrist-joint: posteriorly is a narrow grooved surface for the attachment of ligaments; and anteriorly is a rough surface, the inner or ulnar half of which is narrow and slightly grooved, whilst the outer is prominent and tuberculated for the attachment of ligaments. It articulates with five bones.

THE SEMI-LUNAR BONE.

207. The name of this bone, 2, is taken from its being concave or crescentic on its inferior surface. Irregularly triangular in its form, convex superiorly, it articulates with the square part of the articular surface of the radius; inferiorly concave, with the os magnum and the unciform; on the ulnar side with the cuneiform; on the radial side with the scaphoid; anteriorly and posteriorly it gives attachment to ligaments. It articulates with five bones.

THE CUNEIFORM BONE.

208. This is the "wedge-shaped" bone, 3; sometimes also it is named from its form "pyramidal:" superiorly, it is in relation with the inter-articular fibro-cartilage of the wrist-joint; inferiorly, it articulates with the unciform bone; on the ulnar side, gives attachment to ligaments; on the radial side, articulates with the semi-lunar bone; anteriorly it affords attachment to ligaments, and presents a small articular surface for the pisiform bone. It articulates with three bones.

THE PISIFORM BONE.

209. The "pea-shaped" bone, 4, is placed on a plane, anterior to the other bones of the carpus. Its form is indicated by its name (*pisum*, a pea). It presents but one articular surface, which is situated on the posterior part, or base, and rests on the anterior surface of the cuneiform bone; it affords attachment to the annular ligament of the carpus, to the flexor carpi ulnaris muscle, and to the abductor of the little finger.

The first three carpal bones form, when in apposition, a rounded convex surface, which corresponds with the concavity presented by the radius and the inter-articular cartilage; but their lower surface constitutes a deep hollow, which receives the head of the os magnum and the unciform bone.

BONES OF THE SECOND ROW.

THE TRAPEZIUM.

210. The name of this bone, 5, is taken from its presenting four unequal edges at its posterior aspect. It is placed at the radial border of the carpus, between the metacarpal bone of the thumb and the scaphoid bone. It is known by the angular appearance of its dorsal surface, and by the tubercle and groove at its palmar aspect. Superiorly concave, it articulates with the scaphoid bone; inferiorly, concave from behind forward, and convex transversely, with the first metacarpal bone; on the ulnar side, with the trapezoid bone, and by a small surface situated more inferiorly, with the edge of the second metacarpal bone; on the radial and posterior sides it gives attachment to ligaments; anteriorly it presents a groove, 6, traversed by the tendon of the flexor carpi radialis, and a tubercle to which the annular ligament of the carpus is attached. It articulates with four bones.

THE TRAPEZOID BONE.

211. This is a small bone, 7, compared with those between which it is placed, viz. the trapezium, scaphoid, and os magnum; in form and position it has some resemblance to a wedge, and but little to a trapezium, except that its posterior surface is bounded by four unequal edges. It articulates superiorly with the scaphoid bone; inferiorly, with the second metacarpal bone; on the ulnar side, with the os magnum; on the radial side, with the trapezium: the anterior and posterior surfaces afford attachment to ligaments. It articulates with four bones.

OS MAGNUM.

212. This, 8, is the largest of the carpal bones; its form is oblong, round superiorly, cubic inferiorly; the superior surface, named its "head," (whence it is sometimes called os capitatum,) is supported by a narrowed portion, named the "neck;" its

greatest convexity is in the antero-posterior direction, where it is received into a cavity formed by the scaphoid and the semilunar bone; it articulates, inferiorly, by three distinct surfaces, of which the middle is the largest, with the second, third, and fourth metacarpal bones; on the ulnar side, with the unciform bone; on the radial side, with the trapezoid bone: the anterior and posterior aspects are rough (particularly the former) for the attachment to ligaments. It articulates with seven bones.

THE UNCIFORM BONE.

213. The "hooked-shaped" bone, 9, (uncus, a hook,) is readily distinguished from the rest by the curved process, 10, upon its palmar surface: it articulates, superiorly, with the semilunar bone; inferiorly, by two distinct surfaces, with the fourth and fifth metacarpal bones; on the ulnar side with the cuneiform bone; on the radial side with the os magnum: anteriorly its hooked process affords attachment to the anterior annular ligament of the carpus; posteriorly a rough surface also gives attachment to ligaments. It articulates with five bones.

THE META-CARPUS.

214. This forms the second or middle portion of the hand, being situated between the carpus and the phalanges; it is composed of five bones, which are named first, second, &c. in their numerical order, the enumeration being commenced at the radial side. These bones are placed parallel one with the other, and nearly on the same plane, with the exception of the first, which is more anterior than the rest, and alters its relative position to them in its various movements. They vary in size, the first being thicker and shorter than the others; and these gradually diminish in length from the second to the fifth. They are all slightly concave on the palmar surface, convex on the dorsal, larger at their extremities than in the bodies or middle part, terminated at the carpal extremity by an unequal eminence, and at the digital by a rounded head.

The bodies are lengthened and somewhat compressed, but may, in each, be regarded as presenting a palmar, a dorsal, and two lateral surfaces. The palmar surface is narrow, and presents in the middle a prominent line, which separates the attachments of the inter-osseous muscles, and corresponds with the tendons of the flexor muscles; as also, in the first, to the opponens and flexor brevis pollicis, and in the third to the origin of the adductor pollicis.

The dorsal surface, convex and smooth in the first, presents, in the second, third, and fourth, a longitudinal line, which, bifurcating, forms the sides of a triangular surface, extending over two-thirds of their length; in the fifth, also, is observed a prominent longitudinal line, directed, obliquely, from the ulnar to the radial side. The lateral surfaces afford attachment to the dorsal inter-osseous muscles; broad in the four last bones, these surfaces are narrowed, and form merely borders in the first.

The carpal extremity presents, in each, some peculiarities which render a separate description necessary; on the first is observed a surface, which is concave in the antero-posterior, and convex in the opposite direction, which articulates with the trapezium;—in the second, a concave surface articulates with the trapezoid bone, and on the radial side, a small surface, with the trapezium; at the ulnar side, its margin is extended obliquely backwards, so as to become wedged in between the trapezium and the third metacarpal bone, and articulates by its tip with the os magnum;—on the third, a nearly plain surface articulates with the os magnum; on the radial and ulnar sides are surfaces for articulation with the contiguous metacarpal bones;—on the fourth, two articular surfaces move upon the os magnum and unciform, on the radial side there are two surfaces, and on the ulnar side one, for articulation with the corresponding surfaces of the bones on each side;—on the fifth, a concave surface, directed outwards, corresponding with the unciform bone; and, on the radial side, a surface for the fourth metacarpal bone.

The anterior, or digital, extremities of all are convex, and articulated with the phalanges, the smooth surfaces extending farther on the palmar than on the dorsal aspect of the bones; and on the margins of these are inequalities for the attachment of ligaments.

BONES OF THE FINGERS.

215. These are fourteen in number; each, with the exception of the thumb, having three separate pieces (*phalanges*, *internodia*). Of these the first is longer than the second, and the second than the third. Like other long bones, each is divided

into a body and two extremities, of which one represents the base and the other the head. Winslow, and some other anatomists, reckon three phalanges in the thumb, as they conceive that its posterior, or most movable bone, resembles the first phalanges of the fingers, rather than the metacarpal bones. But if its conformation be examined with attention, more especially that of its anterior extremity, and also its mode of articulation with the bone in front of it, its analogy with the metacarpal range will appear more striking than with the first digital phalanges; and so it is considered by Meckel, Portal, H. and J. Cloquet. The bodies of the first row or phalanx are convex on the dorsal surface, and flat from side to side on the palmar, but arched from before backwards; the palmar surface is bounded by two margins which give insertion to the fibrous sheaths of the flexor tendons. The larger, or posterior extremities, present an oval smooth surface, whose greatest diameter is from side to side, intended to receive the convex heads of the corresponding metacarpal bones. The anterior extremities, smaller than the other, end in two small lateral condyles, with a slight groove between them, both being adapted to the base of the contiguous bones, so as to form ginglymoid, or hinge-joints. The articular surface is prolonged farther on the palmar than on the dorsal aspect, which allows a more free range to the motion of flexion. The margins of the articular surfaces are rough and prominent for the attachment of ligaments.

The second row consists of four bones, the thumb having only two pieces corresponding with those of the first and last phalanx. Smaller than the preceding set, they still resemble them in their general outline. The broader, or posterior extremity, ends in an articular surface, divided by a slight ridge extending from before backwards, the lateral parts being concave, for the reception of the two eminences on the contiguous bone; the anterior extremity is divided into two lateral convex surfaces, which are lodged in depressions in the base of the last phalanx.

The third row (*phalanges unguium*, Sœmm.) consists of five pieces, that of the thumb being the largest. They are convex on the dorsal, flat on the palmar surface, rough at the summit, which corresponds with the points of the fingers, and at the base, for the attachment of ligaments and the flexor tendons. The articular surface, at the base, resembles that of the base of the second phalanx, in having two shallow concavities divided by a central convex line.

Attachments of muscles.—1. To the carpal bones. The *pisiform* bone gives origin to the abductor minimi digiti, and insertion to the flexor carpi ulnaris; the *trapezium* to the opponens and abductor pollicis; the *trapezoid* to part of the flexor brevis pollicis; the *os magnum* to part of the same; the *unciform* to the flexor brevis (minimi digiti) and to the adductor.

2. To the metacarpal bones. The *first*, or that of the thumb, gives insertion to the extensor ossis metacarpi pollicis and to the opponens pollicis, and origin to part of the abductor indicis: the *second*, or that of the forefinger, to the flexor carpi radialis at its palmar end, and to the extensor carpi radialis longior on the dorsal surface of its base, and by its lateral surfaces, to the two first dorsal inter-ossei muscles and one palmar: the *third*, to the extensor carpi radialis brevior, to the adductor pollicis, and also to two dorsal inter-ossei: the *fourth*, to two dorsal inter-ossei and one palmar: the *fifth*, to the extensor carpi ulnaris, and the adductor or opponens minimi digiti, to one dorsal and one palmar inter-osseous muscle.

3. To the bones of the fingers. Those of the *first* range of the four fingers give attachment by their lateral borders to the tendinous sheaths of the flexor tendons; their dorsal surface is covered by the expansion of the extensor tendons. The bones of the *second* row give insertion at their dorsal surface to the tendons of the extensor communis; the tendons of the flexor sublimis are inserted into their bases at the palmar surface: the *third* set gives insertion to the tendons of the flexor profundus; the fibres of the extensor communis are also continued on their dorsal aspect.

The *first* phalanx of the thumb gives insertion to the extensor primi internodii, to the flexor brevis, to the adductor and abductor pollicis: the *second* phalanx to the flexor longus, and to the extensor secundi internodii.

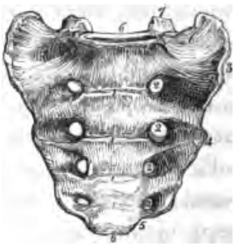
OF THE PELVIS.

216. The pelvis, or "basin-shaped" cavity, is placed at the lower extremity of the trunk, being formed by the union of the ossa innominata, the sacrum, and the coccyx. Its form is some-

what circular; its size presents many varieties, dependent on the sex and age of the subject, as well as on individual conformation. In young subjects the two large lateral bones, the ossa innominata, are divided each into three pieces, the ilium, ischium, and os pubis; the sacrum consists of five pieces, resembling in some respects the bones of the vertebral column, and hence called false vertebræ; these in adult age become united into one. The coccyx, or caudal prolongation, consists of four pieces.

THE SACRUM.

Fig. 57.



217. The sacrum, fig. 57, when the body is in the erect position, is placed at the superior and posterior part of the pelvis, beneath the last lumbar vertebra, above the coccyx, and between the ossa innominata, between which it is inserted, in some measure like a key-stone into an arch.

Its figure is triangular in its general outline; concave anteriorly, convex posteriorly. We consider successively its surfaces, borders, and extremities.

The anterior or pelvic surface, which is here shown, is nearly flat from side to side, concave from above downwards, and marked by four transverse lines, 1, indicating its original division into five pieces; laterally it presents four foramina, 2, (anterior sacral,) for the transmissionof the anterior branches of the sacral nerves. These are directed outwards, and diminish gradually in size from above downwards; external to these the surface gives attachment to the pyramidalis muscle.

The posterior or spinal surface is convex, and presents along the median line four small eminences, usually connected so as to form a ridge; these are rudiments of the spinous processes; and beneath them is a triangular groove, or rather an opening, marking the termination of the sacral canal. The margins of the opening present two tubercles, which give attachment to the ligament that closes in the canal. The inferior pair (sacral cornua) articulate with the horns of the coccyx. At each side of the median line are two grooves, pierced by the posterior sacral foramina, which are much smaller than the anterior, and transmit the posterior branches of the sacral nerves.

The borders, or lateral surfaces of the sacrum, present two distinct parts, one superior, 3, (iliac,) large and irregular, which in the fresh state is covered with cartilage, and articulated with the ilium; the other inferior, 4, thin and narrowing to a point, gives attachment to the sacro-sciatic ligaments. A small indentation, 5, terminates this border, which, with the corresponding extremity of the coccyx, forms a notch for the transmission of the fifth sacral nerve.

The *base*, or superior extremity, broad and expanded, presents, 1st, towards the middle line, an oval surface, 6, cut off obliquely, and tipped with cartilage for its articulation with the last lumbar vertebra; behind this is a triangular aperture marking the orifice of the sacral canal. 2nd, on each side a smooth convex surface, inclined forwards, and continuous with the iliac fossa; an articular process, 7, concave from side to side, which looks backwards and inwards, and receives the inferior articular process of the last lumbar vertebra. Before each articular process is a groove, forming part of the last inter-vertebral foramen, and behind them is a curved, sharp, and depressed border which bounds the sacral canal, and therefore corresponds with the lateral arches of the vertebræ, and gives attachment to the last ligamentum subflavum.

The *apex*, or inferior extremity, 8, directed downwards and forwards, presents an oval convex surface, which articulates with the coccyx.

The sacrum in its interior contains much loose spongy substance, and its exterior layer is but moderately compact. Its central part is also hollowed into a canal (sacral), which curves from above downwards as the bone does; hence it is of a triangular form, and gradually narrows as it descends.

Attachments of muscles.—The sacrum gives attachment, by the lateral parts of its anterior surface, to the pyramidales muscles; by its posterior surface at each side to the gluteus maximus, sacro-lumbalis, longissimus dorsi, and multifidus spinæ; by the inferior part of each border to part of the coccygeus.

Articulations.—The sacrum articulates with the last lumbar vertebra, the two iliac bones, and the coccyx.

Developement.—In the first three pieces there are found five bony points, one being in the body, two at the sides in front, and two posteriorly in the arches. Analogy would lead us to admit two more in each body corresponding with its upper and lower surfaces, and one in the spinous process, in all eight. In the two lower false vertebræ there appear to be but three, one being in the body and one at each side.

OSSA COCCYGIS.

218. These bones, when united together, which is usually the case in advanced life, are supposed to resemble a cuckoo's bill, and are therefore called coccygeal (*κοκκυξ*, a cuckoo). Most commonly there are four of them, sometimes but three; in a few instances five have been found. They diminish gradually in size from above downwards, which gives them, when taken together, a pyramidal form. As they are placed in a continuous line with the inferior third of the sacrum, they form a slightly concave surface anteriorly, a convex one posteriorly.

The first of these bones resembles, in some measure, the last false vertebra of the sacrum. Its body is small and concave at its upper aspect, which articulates with the extremity of the sacrum; posteriorly, two small processes, termed cornua, project, which rest upon the sacral cornua. The second bone of the coccyx is somewhat square, the third oblong, and the fourth a small rounded nodule of bone.

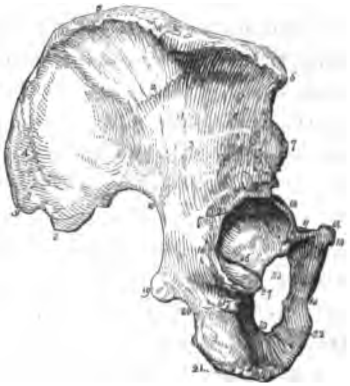
Attachments of muscles.—The coccyx gives attachment to the gluteus maximus, and to the coccygeus of each side, and by its point to the sphincter ani. Its base articulates with the sacrum.

Each of these pieces has a separate osseous centre.

OS INNOMINATUM.

219. This bone, fig. 58, is of so complex and irregular a form, that it bears no perceptible resemblance to any other known object, and therefore remains "unnamed" and unnameable. The two bones thus distinguished by the negation of a name are situated at the inferior and lateral parts of the trunk, extending from the sacrum forwards to the median line, where they are connected together. Through the intervention of the sacrum, which is wedged in between them, they receive the

Fig. 58.



weight of the body, from the vertebral column, and transmit it to the lower extremities; thus placed, and being somewhat curved in their general outline, they circumscribe the greater part of the cavity of the pelvis, the sides and fore-part of which they form.

To facilitate the description of this very irregular bone, it is convenient to consider separately each of the parts into which it is found divided in early life, viz. the ilium, os pubis, and ischium.

220. The *ilium* (os ilii), or iliac portion of the os innominatum, constitutes the upper part of the bone where it is broad and expanded; it is situated at the superior and lateral part of the pelvis. Its surfaces, borders, and angles must be considered successively.

The external surface (*dorsum*), 1, convex before, concave posteriorly, is marked by two curved lines running from before backwards; the superior one, 2, commencing at the anterior superior spinous process, arches downwards to the margin of the sacro-sciatic notch. A space, narrowed before, and wider posteriorly, is included between the line just noticed, the margin of the crista ilii, and the border of the rough surface for the attachment of the gluteus maximus; from this space the gluteus medius arises. The inferior curved line, 3, is shorter and less strongly marked than the superior; it commences at the anterior inferior spinous process, and inclines backward to the sacro-sciatic notch. The space between these lines gives origin to the gluteus minimus. On its posterior and superior part is observed a rough surface, 4, which gives attachment to the gluteus maximus muscle. The internal surface of the ilium is divided into three parts. One anterior, smooth, concave, and of considerable extent, is called the *iliac fossa;* the posterior one is rough and uneven, and serves for its articulation with the sacrum; whilst the third is smooth, much smaller than the others, and is the only part that enters into the formation of the true pelvis.

The superior border, 5, (*crista ilii,*) extending from before backwards, is convex and arched; it forms an epiphysis in infancy, and is sometimes called the *spine* of the ilium, but more properly its crista; its anterior extremity curves inwards, the posterior outwards. This border presents an external and internal lip (*labium*), and a rough interval, to each of which muscles are attached.

The anterior border, depressed and excavated, descends from the superior border or crista towards the os pubis, with which it is continuous; its junction with the crista is marked by a prominent point, called the *anterior superior spinous process*, 6; and that with the pubis, by an obtuse elevation, common to the two bones, called the *ilio-pectineal* eminence, 12. This border presents two excavations, separated by a prominent point, called the *anterior inferior spinous process*, 7. The interval between the latter and the ilio-pectineal eminence gives transmission to the iliacus and psoas muscles, and that between the spinous processes transmits the external cutaneous nerve, and gives origin to some fibres of the sartorius.

The posterior border also presents two notches, separated by a prominent point of bone, called the *posterior inferior spinous process*, 8; above which is another bony eminence, called the *posterior superior spinous process*, 9; of the notches, the inferior and larger one, 10, contributes to form the sacro-sciatic notch.

Of the three angles of the bone, the two superior ones correspond with the spinous processes (anterior and posterior); the inferior is represented by the constricted part of the bone. Here we observe three surfaces (when the ilium is separated from the os pubis and ischium): one external, smooth, concave, forming part of the *acetabulum*, the deep cavity which receives the head of the femur; one anterior, small and triangular, marking the junction with the os pubis; a third posterior, the junction with the ischium.

Attachments of muscles. — To the interval between the crista and the superior curved line on the dorsal surface, is attached the gluteus medius; to the space between the curved lines, the gluteus minimus; to the posterior rough surface, the gluteus maximus; to the internal surface, or iliac fossa, the iliacus muscle.

To the anterior half of the external lip of its crista is attached the obliquus externus abdominis; to the posterior third of the same lip, the latissimus dorsi; to the anterior two-thirds of the interval between the lips, the obliquus internus; and to the remainder, the erector spinæ; to the anterior three-fourths of the inner lip, the transversalis abdominis; to the posterior fourth of the same lip, the quadratus lumborum.

To the external surface of the anterior superior spinous process is attached the tensor vaginæ femoris; to the process and the notch beneath it, the sartorius; to the anterior inferior spine, the straight tendon of the rectus femoris; and to the brim of the acetabulum, the external tendon of that same muscle.

Articulations.—This bone articulates with the sacrum, and joins by bony union with the os pubis and the ischium.

OS PUBIS.

221. The pubic bone forms the anterior and inner part of the os innominatum; and is usually divided into two portions, one superior and thick, called the body, the other inferior and thin, the ramus.

The *body*, fig. 58, 11, horizontal in its direction, presents three surfaces, separated by three prominent lines. The superior surface, slightly depressed, is covered by the pectineus muscle; the internal is smooth, and forms part of the pelvic cavity; the external or inferior is somewhat grooved transversely, overhangs the obturator foramen, and looks downwards to the top of the thigh.

The external extremity of the bone is thick, and presents three faces; one, concave, forms part of the acetabulum; another, superior, connects it with the ilium (the junction being marked by a rounded elevation, 12, called the *ilio-pectineal eminence*); the third, inferior, is joined with the ischium. The internal extremity, 13, flat and compressed, is joined to the corresponding part of the opposite bone by an intervening cartilage, the junction being termed the *symphysis pubis* (συμφυμι, to grow together). Leading outwards from the symphysis, whose direction is vertical, may be observed another margin, nearly an inch in length, which is placed horizontally, and named the *crista*. The angle formed by the crista and symphysis, is termed the angle of the pubes, 14; the crista is terminated externally by a projecting nodule of bone—the *tuberosity* or spine, from which runs outwards a sharp line, (*ilio-pectineal line*,) giving attachment to Gimbernat's ligament, and to the pectineus muscle, and marking the margin or upper boundary of the true pelvis.

The *ramus*, or branch of the bone, 15, inclines outwards and downwards from the body, forming an angle with it, becomes thin, and unites with the ascending ramus of the ischium. Its inner surface is smooth; the external is rough, for the attachment of muscles. One of its borders, thick and rough and somewhat everted, forms with the opposite bone an arch, called the *arch of the pubes;* the other border, sharp and thin, forms part of the margin of the obturator foramen.

Attachments of muscles.—To the crista are attached the pyramidalis and rectus abdominis; to the tuberosity and anterior surface, the obliquus externus; to the pectineal line, the pectineus and Gimbernat's ligament; to the crista, and part of the same line, the obliquus internus and transversalis.

To the external surface, at the angle, the adductor longus; to the space between this and the border of the obturator foramen, the adductor brevis; to the line of the symphysis and the ramus, the gracilis; and to the whole margin of the foramen, the obturator externus. To the inner surface, part of the obturator internus and levator ani.

ISCHIUM.

222. The *ischium* forms the posterior and lowest part of the os innominatum; it consists of two parts, a body and a ramus, united at an angle, so as to give the bone somewhat the figure of a hook. The *body*, fig. 58, 16, or larger part, short, thick, and somewhat triangular in form, presents three surfaces or aspects which look in different directions; there are three borders, and two extremities. On its external surface may be observed a smooth concave part, which forms more than two-fifths of the acetabulum, and is surrounded by a curved prominent line, which forms the lower border of that cavity; beneath this is a groove, 17, directed horizontally backwards, corresponding with the tendon of the obturator externus muscle; and still lower a

rough line, 18, which bounds the tuberosity of the ischium, and gives attachment to the quadratus femoris. The internal surface of this portion of the bone is smooth, and forms part of the cavity of the pelvis. This is broad at its upper part, as it comprises the interval between the spine or spinous process, 19, and the margin of the obturator foramen. Below this process it becomes narrowed, constricted, and rounded off at its back, so as to form a pulley-like surface, 20, in the interval between the spine and the tuberosity where the obturator internus muscle winds round its border. The posterior surface, broad at its upper part where it comprises the space between the spine and the margin of the acetabulum, then becomes narrowed and depressed, finally ends in a rough and rather prominent surface bounded by well-defined borders, which is the tuberosity of the ischium.

The *tuberosity*, 21, (*tuber ischii*,) thick and rounded, forms the part on which the body is supported in the sitting position. This rough prominence presents three impressions upon it, corresponding with the points of attachment of the three long flexor muscles of the leg.

The superior extremity of the bone (if it be examined in early life, when the bone can be detached from the ilium and os pubis, or after a section has been made of the os innominatum, so as to divide it into its three parts,) presents three surfaces, of which two are flat and triangular, and mark its junction with the ilium and os pubis; the other, concave and smooth, forms part of the acetabulum. The inferior extremity of the body of the bone is identified with the tuberosity. The *ramus*, 22, of the ischium is the flat, thin part, which ascends forwards and inwards from the tuberosity, towards the ramus of the os pubis with which it is united. One margin of the ramus, thick, rough, and somewhat everted, forms part of the inferior outlet of the pelvis; the other, thin and sharp, bounds the obturator foramen; its external surface looks outwards and downwards, is rough for the attachment of muscles; the inner surface forms part of the lower circumference of the pelvis.

Attachments of muscles.—To the outer border of the tuberosity and the contiguous part of the ramus, the adductor magnus; to the inner margin of the tuberosity at its fore-part, the erector penis; to the adjacent margin of the ramus, the transversus perinæi; the internal obturator muscle to the inner surface of the bone behind the thyroid or obturator foramen.

To the posterior surface of the tuberosity, the three flexors of the leg, scil. the biceps, semi-tendinosus, and semi-membranosus; to the rough line on the outer surface which bounds the tuberosity, the quadratus femoris; to the external surface of the spine, the gemellus superior; to the adjacent border of the tuberosity, the gemellus inferior; to the internal surface of the bone, the levator ani; and to the spinous process, the coccygeus.

Developement.—The three pieces which form the os innominatum commence each with a separate point of ossification, and the extension of the osseous deposit proceeds in each towards the acetabulum as a common centre, so that when completed it is found to consist of a portion of each. Besides these, the spine of the ilium and the tuberosity of the ischium are formed separately.

223. *Acetabulum.*—At the junction of the three pieces of the os innominatum, 23, is situated the cavity which articulates with the head of the femur. It is called *acetabulum*, also the *cotyloid*, or cup-shaped cavity (*κοτυλη*, a cup; *ειδος*, like). Of this the ischium forms somewhat more than two-fifths, the ilium somewhat less than two-fifths, the remainder being made up by the os pubis. It is surrounded in the greater part of its extent by a margin or supercilium, 24, which is most prominent towards the superior and external part; but at the opposite point, or towards the obturator foramen, it is deficient, leaving a notch, 25 (*cotyloid notch*, sometimes also called *incisura acetabuli*). The greater part of the cavity is covered with cartilage in the natural condition; but towards the notch there is a part depressed beneath the rest, 26, and which corresponds with the passage of the round ligament, and lodges some synovial cryptæ: this has no cartilaginous coating.

224. When we examine the pelvis as a whole, we observe that these articulating cavities, placed in the lateral walls of the pelvis, look outwards and forwards, and that they rest, when the body is erect, upon the globular heads of the thigh bones, which they lodge. The margin of each cavity is rough and uneven; but in the recent state it is rendered smooth, and the depth of the cavity is increased, by a fibro-cartilaginous rim, which runs

round it, and increases its depth. Where the osseous margin is deficient (at the cotyloid notch), its place is supplied by a fibrous band, so stretched across, as not altogether to fill it up, but rather to bridge it over, leaving a space beneath it for the entrance of vessels into the interior of the joint.

To the inner side of the acetabulum is found, in the dried bone, a large aperture, 27; which, however, in the natural condition, is almost completely closed by a fibrous membrane. It is called *foramen obturatorium*, perhaps more properly *obturatum*, from the circumstance of its being closed by a membrane or ligament. It is also called *foramen thyroideum* (shield-shaped, *θυρεος*, a shield), from its shape; and not unfrequently *foramen ovale.* It is somewhat of an oval form in the male, its greatest diameter being extended obliquely downwards and outwards; in the female it is a three-sided figure, with rounded angles.

GENERAL CONFORMATION OF THE PELVIS.

225. The *pelvis*, or basin-shaped cavity, which is thus made up of the ossa innominata, the sacrum, and coccyx, deserves to be attentively examined, not merely as to the details of the parts which compose it, but as to its general conformation. Taking the objects which are deserving of notice on the external surface, from before backwards, and beginning at the median line, we observe the *symphysis* pubis, or the line of junction between the two bones of that name; its direction is vertical, its depth greater in the male than in the female; beneath it is an angular space, the *pubic* or *sub-pubic arch*, bounded by the rami of the ossa pubis and ischia at each side. On each side of the arch is the *thyroid* or *obturator* foramen above noticed, and still more laterally the *acetabulum*, above which rises the broad convex part of the ilium (dorsum ilii). Posteriorly, along the middle line, are situated the tubercles or spinous processes of the sacrum; external to these, the posterior sacral foramina, and next, a broad, unequal surface, to which the sciatic ligaments and gluteus maximus are attached; and lastly, the large deep excavation (*sacro-sciatic notch*), bounded by the margins of the sacrum and os innominatum.

The internal surface is divided into two parts by a prominent line (*linea ilio-pectinea*) leading from the tuberosities of the ossa pubis, outwards and backwards, to the prominent point of the sacrum (*promontorium*). This constitutes the margin or brim of the *true* pelvis, all the part above it being called the *false* pelvis; as in reality it belongs to the abdomen.

The superior circumference of the false pelvis is formed on each side by the crista ilii; posteriorly may be observed a deep notch, which is divided into two parts by the base of the sacrum, and anteriorly (in the interval between the anterior-superior spinous processes of the ilia) the margin of the bone subsides, so as to present a deep excavation, which in the natural condition is filled up by the soft parietes of the abdomen. Along this margin are placed the anterior-inferior spinous processes of the ilia, the ilio-pectineal eminences, the spines or tuberosities of the ossa pubis, with their cristæ and angles. The inferior circumference or outlet of the pelvis presents three bony eminences (the tuberosities of the ischia on the sides, and the coccyx behind in the middle line). These are like so many promontories, separated by deep excavations. The anterior one (*pubic arch*), triangular in its form, is bounded on each side by the rami of the ischia and ossa pubis, extending upwards and inwards, from the tuberosities of the ischia to the symphysis pubis. The two other notches (*sacro-sciatic*) are placed behind and above the tuberosities, and correspond with the interval between the sacrum and os innominatum. When examined in the dried bones, their extent is considerable; but in the natural condition they are divided into lesser spaces by the sacro-sciatic ligaments.

226. The size and conformation of the pelvis differ very remarkably in the two sexes. In the female the bones are thinner, more smooth on the surface, the muscular impressions being less strongly marked, and, though its perpendicular depth is less, its breadth and capacity are greater. The alæ of the iliac bones are more expanded; the upper aperture is more nearly circular, the projection of the sacrum less perceptible; and the space between the tuberosities of the ischia greater. The depth of the symphysis pubis is less in the female than in the male, whilst the breadth of the pubic arch is greater.

227. In the erect attitude of the body, the direction of the pelvis is oblique, its upper aperture being inclined forwards; so much so, that if a line be drawn from the upper border of the symphysis pubis, backwards to the sacrum, it rests against the

middle of that bone. In consequence of this inclination, the central line, or axis of the inlet, differs very decidedly from that of the outlet; the former, if drawn from above downwards, reaches the lower third of the sacrum; the latter, if drawn from below, backwards and upwards, touches the promontory of the sacrum; both therefore decussate towards the centre of the pelvic cavity. The different dimensions of the male and female pelvis are stated as follows, by Meckel, Cloquet, and Burns:—

	Meckel.				Cloquet.		Burns.	
	In the male pelvis.		In the female pelvis		Female.		Female.	
	inch.	lines.	inch.	lines.	inch.	lines.	inch.	lines.
Between the anterior-superior spinous processes of the ilia	7	8	8	6	10	0	10	0
Between the middle points of the cristæ of the ilia	8	3	9	4	11	1	11	1
The transverse diameter of the inlet	4	6	5	0	5	6	5	6
The oblique . . . of the inlet	4	5	4	5	4	7	5	5
The antero-posterior . of the inlet	4	0	4	4	4	4	4	0
The transverse diameter of the cavity	4	0	4	8	—		—	
The oblique . . of the cavity	5	0	5	4	—		—	
The antero-posterior . of the cavity	5	0	4	8	—		—	
The transverse . . of the outlet	3	0	4	5	4	4	4	0
The antero-posterior . of the outlet	3	3	4	4	4	4	4	0

The last may be increased to five inches in consequence of the mobility of the coccyx.

BONES OF THE LOWER EXTREMITY.

228. The lower extremity is made up of three parts; the thigh, leg, and foot.

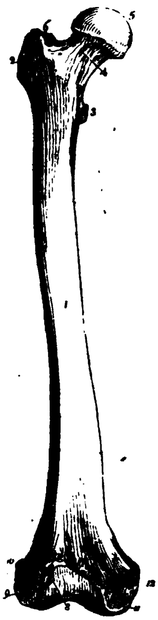
The osseous part of the first consists of one bone—the femur; that of the leg, of two—the tibia and fibula. The adjacent extremities of these, together with the patella (a sort of sesamoid bone), form the knee.

The foot is composed of three parts, the tarsus, metatarsus, and phalanges.

THE FEMUR.

229. The femur or thigh-bone, fig. 59, (*os femoris,*) the longest bone of the skeleton, is situated between the pelvis and the tibia. In the erect position of the body, its general direction is not vertical; it gradually inclines inwards towards the

Fig. 59.



lower part, so that the bones of opposite sides, though separated at a considerable distance where they are connected with the pelvis, approach each other inferiorly, and come nearly in contact. The degree of this inclination varies in different persons, and is more marked in the female than the male. The femur presents a central part, or body, and two extremities.

The *body*, 1, or shaft, as it is sometimes called, compressed, but nearly cylindrical towards the centre, and at the same time slightly convex or arched forwards, is expanded superiorly and inferiorly. Its anterior surface, convex and smooth, is broader towards the lower than the upper extremity. Both its lateral surfaces are compressed and somewhat flat; but it may be observed that the external is somewhat concave ; it affords attachment to the vastus externus muscle. The surface, which superiorly looks inwards, is, in the lower third of the bone, inclined somewhat backwards, and gives attachment to the vastus internus. The anterior surface is separated, though not in a very marked degree, from the lateral surfaces by two lines, which may be traced upwards from the condyles, towards the superior extremity of the bone ; but posteriorly, at the union of the two lateral surfaces, is a rough and prominent line (*linea aspera*), which gives attachment to several muscles.

The *linea aspera* is most prominent towards the centre of the bone, and, when examined with attention, presents two margins and a rough interstice, each giving attachment to muscles. Above and below the centre, it subsides as it were towards the extremities, and also becomes bifurcated. The two superior divisions or branches of the line terminate, the one (internal and somewhat shorter) at the lesser trochanter ; the other, external, at the greater trochanter ; in the course of the latter a rough strongly-marked impression exists, which gives insertion to the gluteus maximus. The inferior divisions spread more asunder, and terminate at the condyles, enclosing between them and the margins of these prominences, a flat triangular portion of the bone, which corresponds with the popliteal vessels. Towards the superior part of the linea aspera may be observed a foramen directed from below upwards, which transmits the medullary vessels.

At the superior extremity of the bone is placed its neck, which is directed upwards and inwards, so as to form an obtuse angle with the body or shaft; at its point of union with the latter are two eminences (*trochanter*, major and minor), one on the outer, the other on the inner side; it is from between these that the neck arises.

The *trochanter major*, 2, is prolonged from the external surface of the body of the bone, and nearly in a line with its axis. This apophysis, quadrilateral in its form, is convex and rough on its external surface, which is marked by a line directed obliquely downwards and forwards for the attachment of the gluteus medius; the internal surface, of less extent, presents at its base a pit, 6, (*trochanteric* or *digital fossa*,) which receives the external rotator muscles; its superior, or terminal border, is flat and straight, and the posterior thick and rounded. At the posterior aspect of the great trochanter may be observed an oblique and prominent line, directed downwards and inwards, and terminating in the trochanter minor.

The *trochanter minor*, 3, a conical rounded eminence, projects from the posterior and inner side of the bone, and gives attachment to the tendon of the psoas and iliacus muscles.

230. The *neck* of the femur, 4, which is so named from its constricted appearance and supporting the head, forms an obtuse angle with the body of the bone; it is compressed from before backwards, so that its diameter in this is much less considerable than in the vertical direction, in which greater power of resistance is required, for sustaining the weight of the body; its anterior surface is broad and smooth; the superior, inclined upwards, is short and somewhat concave; the inferior is the most extensive. The union of the neck with the rest of the bone is marked by the trochanters and two intervening oblique lines, (*inter-trochanteric*,) of which, the anterior one is rough, and but slightly prominent; the other, situated posteriorly, forms a smooth projecting ridge, which overhangs the trochanteric fossa.

The neck is surmounted by the globular *head*, 5, which forms a considerable segment of a sphere, is tipped with cartilage in the fresh state, and lodged in the acetabulum. A little beneath its most prominent point is a small cavity, which gives attachment to the round ligament.

231. The *inferior extremity* of the bone, much thicker and broader than the superior, is terminated by two eminences, separated posteriorly by a deep fossa; these are named *condyles*, of which one is internal, the other external.

The external condyle, 7, is larger, and projects forwards more than the internal; its articulating surface also is broader, and mounts higher up anteriorly; its external surface, rough and unequal, presents a deep pit, 9, inferiorly, which gives attachment to the tendon of the popliteus muscle; and immediately above it, a projection, 10, (*external tuberosity*,) which gives attachment to the external lateral ligament of the knee-joint.

The internal condyle, 11, appears longer, and also to descend lower down than the other; but this is rather apparent than real, for by means of the obliquity of the shaft of the bone, both condyles are brought to the same plane. The internal condyle presents at its inner side a tuberosity, 12, which gives attachment to the internal lateral ligament of the knee-joint and the tendon of the adductor magnus. In the fossa, between the condyles, posteriorly, are implanted the crucial ligaments.

The articular surfaces of both condyles, covered with cartilage in the fresh state, are united anteriorly where they form a pulley-like surface, 8, concave from side to side, on which the patella glides. Inferiorly, these surfaces diverge as they pass backwards, and when they terminate at the posterior surface of the bone, are separated by a considerable interval.

Articulations.—The femur articulates superiorly with the acetabulum; by its condyles with, inferiorly, the tibia, and, anteriorly, the patella.

Attachments of muscles.—To the anterior surface the crureus; to the two lateral and to both lips of the linea aspera, are attached the vastus internus and externus; to the centre of that line, the adductors and the short head of the biceps flexor; to the superior border of the trochanter major, the gluteus medius; to its anterior border, the gluteus minimus; to the fossa, at its posterior surface, the external rotators; to the lesser trochanter, the tendon of the psoas and iliacus; to the line between the trochanters, posteriorly, the quadratus femoris; to the line below the lesser trochanter, the pectineus; to the rough impression beneath the great trochanter, the gluteus maximus; just above the inner and outer condyle, the corresponding heads of the gastrocnemius; to the external condyle, the plantaris; to the fossa beneath the external tuberosity, the popliteus.

Developement.—The femur grows from five osseous centres; one being in the middle of the shaft, which appears very early; the two trochanters and the head commence by separate points; and there is one at the lower extremity, which is evolved into the two condyles.

THE PATELLA.

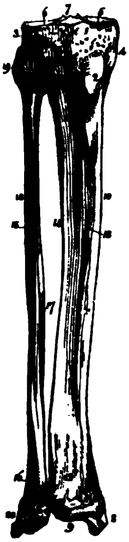
232. The patella (rotula, knee-pan,) is situated at the anterior part of the knee-joint, being attached by a ligament (*ligamentum patellæ*) to the tibia, so that its position with regard to the joint varies according to the movements of that bone. Compressed and somewhat triangular in its form, its anterior surface is convex, and covered by the expanded fibres of the extensor tendons; the posterior, smooth and covered with cartilage for its articulation with the condyles of the femur, is divided into two parts by a vertical line, the external being the broader. Beneath these is situated a small irregular depression, corresponding with the apex, or narrowest part of the bone, which gives attachment to the ligamentum patellæ. The superior extremity, broad and rounded off at its margin, gives attachment to the extensor muscles; the inferior, narrow and pointed, to the ligament already named; the lateral borders are convex, the external being thinner than the internal.

THE TIBIA.

233. The tibia, next to the femur, is the longest bone in the skeleton; situated at the anterior and inner side of the leg, it alone receives from the femur (under which it is placed vertically,) the weight of the trunk, and communicates it to the foot. Like the other long bones, it is divided into a body and two extremities.

The *superior extremity*, fig. 60, 1, much thicker and more expanded than any other part of the bone, (being proportioned in size to the lower extremity of the femur), is broader from side to side than from before backwards; its circumference is somewhat rounded and convex in front and at the sides, but

Fig. 60.



slightly hollowed posteriorly; at the fore-part, a little below the head, is situated an eminence, 2, sometimes called the anterior tuberosity, more properly the *tubercle*, which is somewhat rough at its lower part, for the attachment of the ligament of the patella, and smooth superiorly, where it corresponds to a small synovial bursa, intervening between that ligament and the bone. On the sides, and above this, are two rounded eminences (*tuberosities*), the external one, 3, being somewhat smaller than the other, 4, and marked posteriorly by a flat surface, which articulates with the head of the fibula; these processes give attachment to the lateral ligaments of the knee-joint. On the superior aspect of this portion of the bone may be observed two concave cartilaginous surfaces, 5, 6, (*condyles*,) which sustain the condyles of the femur; the internal one is somewhat the deeper; its greatest diameter is from before backwards; the external one is nearly circular. In the interval between the articular surfaces is situated a pyramidal eminence, 7, the summit of which is usually divided into two tubercles; it is named the spine or spinous process of the tibia; before and behind this are two irregular depressed surfaces, which give attachment to the crucial ligaments and to the semi-lunar cartilages.

The *lower*, or *tarsal* extremity of the bone, is much smaller than the upper, and nearly quadrilateral in its form; the anterior surface, convex and smooth, is bounded below by a slightly rough margin which gives attachment to the anterior tibio-tarsal ligament; the posterior is flat, and marked by a groove for the flexor longus pollicis; the external, slightly concave, is rough superiorly, for the attachment of the transverse ligament, and smooth below, to receive the extremity of the fibula. From the inner border of this end of the bone projects downwards a triangular apophysis, 8, the *internal malleolus;* the inner surface of which is convex, and covered merely by the skin, the external is smooth, and articulates with the side of the astragalus; the anterior forms a rounded border, whilst the posterior is marked by two grooves for the tendons of the tibialis posticus, and flexor longus digitorum; to the most dependent part of the process is attached the internal lateral ligament. The lower articular surface of the tibia, 9, or that part which enters into the formation of the ankle-joint, consists of two parts, one vertical, just described as being situated at the outer side of the malleolus; the other horizontal in its direction, concave and quadrilateral in its form, divided into two parts by a slightly raised line; of these two surfaces, which are united at a right angle, and tipped with cartilage in the fresh state, the latter rests on the dorsum of the astragalus, the former is applied to its inner flat border.

The *body* of the tibia, triangular in its form, diminishes gradually in size for about two-thirds of its length, after which it increases somewhat towards its lower extremity. The internal surface, 10, is convex and subcutaneous, except at the upper part of its extent, where it is covered by the tendons of the sartorius, semi-tendinosus, and gracilis muscles. The external surface, slightly hollowed above, 11, where it gives origin to the tibialis anticus, is convex, and somewhat inclined forwards below, 12, where it is covered by the extensor tendons. The posterior surface is very deeply seated; not so uniform in its outline as the others, it is marked at its upper third by a line extending upwards and outwards to the external tuberosity; the part above this is triangular, and gives attachment to the popliteus muscle, that below it to the tibialis posticus and flexor digitorum, and from the line itself arises the soleus. Near this line may be observed a medullary foramen of large size, whose direction is from above downwards.

The surfaces here indicated are separated by an equal number of borders. The anterior border, 13, more or less sinuous in direction, sometimes considerably curved, is for the most part subcutaneous; sharp and prominent, especially towards the middle, and hence named the *crista* or *spine* of the tibia; it subsides towards the lower end of the bone, as if to allow a smooth surface for the passage forwards of the vessels and muscles, which superiorly are placed on the outer side. The inner border, thick and rounded, gives attachment to the soleus and flexor longus digitorum; whilst the external, 14, somewhat sharp, divides inferiorly into two lines, which diverge towards the surface of articulation with the fibula. The inter-osseous ligament is inserted into this external border. The body of the tibia is slightly twisted, so that the internal tuberosity inclines a little backwards, and the internal malleolus forwards, which conformation deserves attention in the diagnosis and adjustment of fractures.

Articulations.—The tibia articulates with the femur, the fibula, and the astragalus.

Attachments of muscles.—To the external surface and external tuberosity, the tibialis anticus; to the latter also, the head of the extensor longus digitorum; to the inner surface, the sartorius, gracilis, semi-tendinosus, and semi-membranosus; the popliteus to the triangular space on the posterior surface; the soleus, tibialis posticus, and flexor longus digitorum to the rest of its extent, and, through the medium of the patella and its ligament, it may be said to give insertion to the extensors of the leg.

Developement.—There is an osseous centre in the body of the bone, and one at each extremity.

THE FIBULA.

234. This bone (fibula, peroné, περονη, a clasp,) is situated at the external side of the leg; it is nearly equal to the tibia in length, but is much more slender. When the fibula is placed beside the tibia in its natural position, its lower extremity will be found a little farther forward than the upper one, and its shaft inclined backwards and a little inwards so as to be convex in that direction.

The *body* of the bone, irregularly triangular in its form, presents three prominent lines bounding three surfaces; the anterior, fig. 60, 15, or most prominent line, gives origin to muscles in the superior part of its extent, and bifurcates towards its lower extremity, so as to enclose a slightly concave triangular surface, 16, which is subcutaneous; the internal one also gives attachment to muscles, and inferiorly, where it inclines forwards, to the inter-osseous ligament. The *internal* surface, 17, looks backwards for about a third of its extent, and somewhat forwards in the rest, and is divided, but unequally, into two parts, by a slightly marked longitudinal line, to which the inter-osseous ligament is attached for about two-thirds of its length; the part of the surface behind this is grooved,—it gives attachment to the tibialis posticus muscle ; the anterior portion, the smaller, to muscles placed in front of the leg. The *external* surface, 18, concave in the greatest part of its extent, gives origin to muscles,—towards its lower extremity, this surface is inclined backwards, conforming with the peronei muscles, which are connected with the superior part of the bone, and incline in that direction to pass behind the external malleolus. The *posterior* surface, convex and smooth, affords attachment to muscles, and presents towards its middle a small foramen, directed obliquely downwards for the transmission of the medullary vessels; in the lower part it inclines inwards, and is terminated by a rough surface connected with the tibia.

The *superior* extremity of the bone, 19, called also the head, is smaller than the inferior one; it presents on the supero-internal part a small oval and nearly flat surface, for its articulation with the corresponding part of the external tuberosity of the tibia; the remainder is unequal, and gives insertion to the biceps flexor cruris, to the external lateral ligament of the knee-joint, and to those which connect the tibia and fibula. The *inferior*, or tarsal *extremity*, 20, forms the external malleolus, which is longer and more prominent than the internal one: in front it receives the insertion of ligaments ; behind is situated a shallow groove traversed by the tendons of the peronei muscles; the outer side is convex and subcutaneous ; the inner presents a small triangular surface, convex in the perpendicular, and nearly plain in the antero-posterior direction, which articulates with the astragalus, and is bounded posteriorly by a rough depression, affording attachment to the transverse ligament of the ankle-joint, whilst the apex gives origin to the external lateral ligament.

Articulations. — The fibula articulates at both extremities with the tibia, and at the inferior one with the outer border of the astragalus.

Attachments of muscles.—The internal surface, by its anterior portion, to the extensor communis digitorum, extensor proprius pollicis, and peroneus tertius ; by the depression on its posterior part, to the tibialis posticus : the external surface, to the peronei; the posterior surface, to the soleus and flexor longus pollicis ; its head, to the biceps flexor cruris.

Developement. — The fibula has an osseous centre for its body, and one for each extremity.

BONES OF THE FOOT.

The foot is composed, like the hand, of three parts, viz. the tarsus, meta-tarsus, and toes; their upper and under aspects are shown in fig. 61 and 61*.

TARSUS.

235. The tarsus is composed of seven bones, viz. the os calcis, astragalus, naviculare, cuneiforme internum, cuneiforme medium, cuneiforme externum, and cuboides.

THE CALCANEUM.

236. This bone, fig. 61, (os calcis—calcaneum,) is situated at the posterior and inferior part of the tarsus, and forms the heel by its projection backwards; elongated in that direction, and compressed laterally, it is the largest of the bones of the foot. Superiorly it presents (taking the objects successively from behind forwards,) a concave portion, 1, intervening between the insertion of the tendo Achillis into its posterior border, and the surface which articulates with the astragalus; then the last-named surface, which is bounded by a rough depression for the insertion of a ligament (inter-osseous), and lastly a narrow concave surface, which also articulates with the astragalus. On the inferior surface, which is narrower than the preceding, and broader behind than before, are observed posteriorly two tubercles, 2, 3, (the internal being the larger,) serving for the attachment of the plantar fascia and the superficial plantar muscles; between them a depression for the origin of the long plantar ligament, and in front another eminence, 4, giving attachment to the inferior ligament (calcaneo-scaphoid) connecting this bone with the scaphoid. The anterior surface, the smallest, is slightly concave, and articulates with the cuboid bone. The posterior surface, convex, presents, inferiorly, inequalities, 5, for the attachment of the tendo Achillis; and, superiorly, a smooth surface, 6, separated from that tendon by a synovial bursa.

Fig. 61.

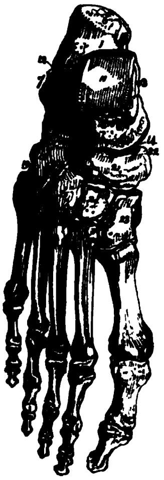
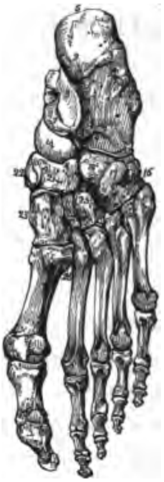


Fig. 61*.



The external surface, broader behind than before, presents, in the latter direction, superficial grooves, 7, for the tendons of the peronei muscles, and is subcutaneous in the rest of its extent. The inner surface, 8, deeply concave, is traversed by the plantar vessels and nerves, and the tendons of the flexor muscles. A groove, 9, runs along at its upper edge, and under the tubercle which surmounts it, for the tendon of the flexor longus pollicis. The calcaneum articulates with the astragalus and the cuboid bone.

THE ASTRAGALUS (ασтϱαγαλος, a die).

237. The astragalus is situated at the superior part of the tarsus; its form is irregular; it appears as if twisted on itself. The upper surface presents, in front, a rough and slightly excavated part, 10, serving for the attachment of ligaments; and behind it a large convex cartilaginous surface, 11, which is longer and more prominent on the outer than on the inner side, broader before than behind, and articulated with the lower extremity of the tibia. On the outer and inner sides are situated two smooth surfaces, 12, 13, (the former the larger,) which are continuous with the preceding, and articulated with the inferior extremities of the tibia and fibula (the *malleoli*). On the inferior surface are observed, in front, and somewhat internally, a narrow convex surface, and behind, a broad concave one, both articulating with the os calcis; these are separated by a groove, which receives the ligament that proceeds upwards from the last-named bone. The anterior surface, 14, convex, is received into the hollow in the scaphoid bone; it is called the *head*, and the constricted part by which it is supported, the *neck* of the astragalus. The posterior surface, or rather border, is grooved and traversed by the tendon of the flexor longus pollicis. The astragalus articulates with the tibia and fibula above, with the os calcis below, and with the scaphoid in front.

THE CUBOID BONE.

238. This bone, (*os cuboides*, *cuboideum*,) is situated at the external side of the tarsus; its form is indicated by its name. The superior surface, 15, rather rough, inclined obliquely outwards and upwards, gives attachment to ligaments. The inferior surface presents, in front, a depression, 16, traversed by the tendon of the peroneus longus muscle, in the middle a transverse ridge, (tuberosity,) 17, and behind it an irregular surface, 18, both of which give attachment to the calcaneo-cuboid ligament; the former also to some fibres of the ligamentum longum plantæ. At the anterior aspect of the bone is a smooth surface, directed from without inwards and forwards, and divided into two parts, the internal one being square, the external triangular, and articulated, the former with the fourth, the latter with the fifth metatarsal bone; at the posterior is a surface by which it articulates with the os calcis. The external border, which is short and rounded, presents a groove, 19, continuous with that on the inferior surface, and serving for the transmission of the tendon of the peroneus longus muscle. On the internal surface may be observed, towards its middle, an elongated smooth, and nearly flat portion, 20, which articulates with the third cuneiform bone, the part before and behind it being rough, for the attachment of ligaments. The cuboid articulates with the fourth and fifth metatarsal bones before, with the os calcis behind, with the external cuneiform, and sometimes with the scaphoid.

THE SCAPHOID BONE.

239. The scaphoid or navicular bone, 21, so named from its excavated form (*σκαφη*, *navis*,) is placed at the inner border of the foot, between the astragalus and the cuneiform bones. It presents a concave surface which looks backwards, and a convex one which is turned forwards. Its inner margin projects in the form of a tubercle, 22, toward the sole of the foot. Upon its upper and inner surface are inequalities for the attachment of ligaments,—behind, a concavity for the head of the astragalus,—in front, three distinct surfaces for articulation with the three cuneiform bones; at its lower and inner border is the prominence or tubercle, above noticed, which gives attachment to the

tibialis posticus muscle; on the outer side, in some instances, is a small articular surface, by which it is united to the cuboid bone. It articulates with the three cuneiform bones, with the astragalus, and sometimes with the cuboid.

THE CUNEIFORM BONES.

240. These bones, 23, 24, 25, (ossa cuneiformia, wedge-shaped,) constitute the anterior and inner part of the tarsus; the name expresses their form. In number three, they are distinguished by their numerical order from within outwards. The first is the largest, and has its base or broad border turned down into the sole of the foot,—the second, or middle, the smallest. The base, or broad border, of the second and third is at the upper or dorsal surface of the foot, and contributes to give it its arched form. They articulate behind with the navicular, and in front with the first, second, and third metatarsal bones. In consequence of their excess in length over the second, the first and third, in addition to articulating laterally with the corresponding sides of that bone, are in apposition with the base of the second metatarsal bone, which is inserted between them. The inner side of the first is subcutaneous, and the outer side of the third articulates, by a smooth flat surface with the cuboid, and by a small linear facette with the fourth metatarsal bone.

Attachments of muscles.—The os calcis, by its dorsal surface, to the extensor brevis digitorum pedis; the inferior half of the posterior surface to the common tendon of the gastrocnemius and soleus (*tendo Achillis*), and to that of the plantaris; the inferior surface on the inner side, to the flexor accessorius, and part of the abductor pollicis: on the outer side, to the abductor digiti minimi; and between the two abductors, to the flexor brevis digitorum.

The cuboid bone, by the inferior surface, to a portion of the adductor pollicis.

The scaphoid bone, by its tuberosity, to a portion of the tendon of the tibialis posticus.

The cuneiform bones. The first, by its base, to portions of the tendons of the tibialis anticus and posticus, and the second and third to part of the flexor brevis pollicis.

Developement.—These bones have each a separate centre of ossification. The os calcis has a second in its posterior part or tüberosity.

THE META-TARSUS.

241. The second, or middle portion of the foot, is analogous to the corresponding portion of the hand (meta-carpus), and like it is composed of five bones placed parallel one with the other. They are named according to their numerical order, from within outwards. The first, or that supporting the great toe, is the shortest, but it exceeds all the others very considerably in thickness. The second is the longest, and the rest decrease successively in length. In all, the thickness of the extremities, particularly of the tarsal ends, is greater than that of the bodies. The bodies of these bones elongated and somewhat compressed, like the metacarpal bones, may be considered as presenting a dorsal, a plantar, and two lateral surfaces. The dorsal surface of all is covered by the tendons of the extensor muscles, the extensor brevis digitorum, and the vessels and nerves; that of the first is broad, inclined inwards, and bounded externally by a prominent line; in the last it looks outwards, and is bounded on the inner side by a like line. In the others are observed analogous lines, placed in the middle, and separating the attachments of the interossei muscles. The plantar surface corresponds to the deep-seated muscles of the foot, and to ligaments serving to connect those bones. That of the first is broader than any of the others. The lateral surfaces form the interosseous spaces, and give attachment to the interosseous muscles. The tarsal extremity presents, in the first, an oval concave surface, broader above than below, articulating with the first cuneiform bone, and inferiorly a tuberosity for the attachment of the peroneus longus; that of the second metatarsal bone, triangular in its form, is, in consequence of the shortness of the corresponding cuneiform bone, impacted between the two other bones of that name; it gives attachment to ligaments, articulates behind with the second cuneiform bone, on the inner side with the first metatarsal bone, and on the outer with the second. The tarsal end of the third, also triangular, and smaller than the preceding, receives the insertion of ligaments on its upper and under surfaces, and articulates posteriorly with the third cuneiform bone, on the inner side with the second meta-

tarsal bone, on the outer with the fourth. The extremity of the fourth metatarsal bone, cubical in its form, is connected by ligaments to the adjacent bones, and articulates with the cuboid posteriorly, on the inner side with the third metatarsal and third cuneiform bones, on the outer with the fifth metatarsal. The posterior extremity of the fifth metatarsal bone, pyramidal in its form, articulates behind, by an oblique surface, with the cuboid, and on the inner side with the fourth metatarsal bone; on its external and lower side is a rough tuberosity, which forms a considerable projection on the external border of the foot, and gives attachment to the peroneus brevis, and to part of the abductor minimi digiti.

The anterior extremities of the metatarsal bones are convex, and rounded into the form of heads, flattened at the sides and elongated from above downwards. The head is bounded by a groove, or neck, better marked on the upper than on the under surface. These extremities are received into shallow depressions in the first phalanges, with which they are articulated.

PHALANGES OF THE TOES.

242. The toes, which form the last part of the foot, are composed each of three phalanges or rows, except the first, which has but two. The body of the *first* presents three surfaces: one inferior, or plantar, is flat; the others, lateral, are smooth and convex, and meet on the dorsum in a rounded border; they are contracted towards the middle, somewhat rough and broad at the extremities for the attachment of ligaments; concave towards the sole of the foot, and convex superiorly. The posterior extremities, broader than the anterior, are concave, and receive the head of the metatarsal bones. The anterior terminate in two rounded heads, with an intervening pulley-like surface, the lateral parts being received into depressions, in the contiguous extremities of the second phalanges, whilst the middle groove lodges a prominent line marked on the latter.

The bones of the *second phalanx*, much smaller than the first, are somewhat hollowed on the lower surface, and convex on the upper one; their borders are flat and compressed. The posterior extremities are terminated by two small concave articular surfaces separated by a prominent line, by which means they are adapted to the inequalities observed on the contiguous extremities of the first phalanges. The anterior extremities present two small condyles, which articulate with the third phalanges.

The third set are somewhat conical in their figure; the posterior extremities, or base, being hollow for their articulations with the ends of the second phalanges, whilst the anterior is rough and scabrous.

Attachments of muscles.—To the metatarsal bones. The *first* gives attachment to the prolonged tendon of the peroneus longus, to the transversalis pedis, and the first dorsal inter-osseous muscle; the *second* to the first and second dorsal inter-ossei; the *third* to part of the adductor pollicis, to three inter-ossei, and part of the transversalis pedis; the *fourth* to three inter-ossei also; the *fifth* to the peroneus brevis and tertius, the transversalis pedis, part of the flexor brevis minimi digiti, to the fourth dorsal and third plantar inter-osseous muscle.

To the bones of the toes. The *first* phalanx of the great toe gives insertion to the abductor, flexor brevis, and adductor pollicis; the *second* phalanx to the extensor proprius pollicis and flexor pollicis longus; the *second* phalanges of the other toes receive the insertion of the tendons of the flexor sublimis; and the *third* those of the flexor profundus, and of the extensors.

OSSA SESAMOIDEA.

243. These do not properly form part of the skeleton; they may be considered as accessories to the tendons of muscles, and are found only in the limbs, never in the trunk. In the superior extremity, two are always found in the articulation of the metacarpal bone of the thumb with its first phalanx. In the lower extremity, two are frequently found behind the femoral condyles, and constantly beneath the first joint of the great toe, as well as in the tendons of the tibialis posticus and peroneus longus. They are situated in the direction of flexion (the only exception being the patella, which belongs to this class of bones), and serve the purpose of increasing the power of muscles, by removing them farther from the axis of the bone on which they are intended to act.

CHAPTER III.

ARTICULATIONS.

244. THE different pieces of the osseous system being connected together so as to form a skeleton, their modes of union must be as various as their forms and uses. When the union is not immediate, as is the case in the cranial bones, it is effected by means of different substances, such as ligament, cartilage, fibro-cartilage, and fibrous membrane, variously arranged and disposed, so as to permit, in some instances, no perceptible motion; whilst in others a free and extended range is allowed in every direction. Still, all the varieties, however numerous, are usually included under the general term "articulation."

245. The articulations are divided into three classes; viz. the immovable, the movable, and mixed; the last being intermediate in degree between the others. The first form obtains where flat and broad bones are united to enclose cavities for the lodgment of important organs, as in the cranium and pelvis. In some instances the surfaces are indented and reciprocally impacted one into the other, so that complete solidity is insured by the structure of the part; and as this mode of union occurs only amongst flat bones, their deficiency in extent of contact is compensated by the indentations in their margins. There is another set of immovable articulations, in which the surfaces are merely in apposition with one another, yet total immobility is secured by what may be termed a mechanical contrivance. Thus, though the squamous part of the temporal bone merely rests against the inferior border of the parietal, no motion can exist between them, in consequence of the manner in which the petrous portion of the former bone projects into the base of the skull.

246. All the bones of the head and face, except the lower jaw, are joined by immovable articulation, or *synarthrosis* (*συν, together; αρθρον, articulation*), of which there are several forms.

1. The first is called *suture* (sutura, *a seam*). In the true suture the union is effected by indentations in the contiguous margins of bones which are mutually received into one another, as may be seen between the two parietal, the occipital, and frontal bones; any varieties that occur being referable to the form of the prominences. Thus, when they are tooth-shaped, the suture is termed ***sutura dentata;*** if like the teeth of a saw, ***sutura serrata;*** if the adjacent borders be bevelled off, as where the temporal and parietal bones are applied to one another, it is called a squamous suture (***sutura squamosa***). In some parts it may be observed that the mode of union and adaptation are alternated, in order to increase their power of resistance. Thus, at the superior part of the arch of the skull, the frontal overlays the parietal bones, and rests on them; but inferiorly and laterally the reverse takes place, where the parietal rests against the frontal.

When the surfaces are merely placed in apposition with one another, as in the superior maxillary bones, the union is called ***harmonia*** (*ἄϱω, to adapt*).

When a ridge in one bone is received into a groove in another, the articulation is called *schindylesis* (*σχινδυλησις*, a *slit* or *fissure*). The rostrum of the sphenoid, and the descending plate of the ethmoid bone, are joined in this way with the vomer. When a conical surface is impacted into a cavity, the term ***gomphosis*** (*γομφος, a nail,*) is adopted, which may be exemplified by the manner in which the teeth are lodged in the alveoli.

247. In the mixed form of articulation, or ***amphi-arthrosis,*** the bones are connected by an intermediate substance, which allows some degree of motion. The articulations between the bodies of the vertebræ, the union at the pubic symphysis, and that between the two first bones of the sternum, are all constructed on this principle. As the surfaces in these cases are flat and plain, they possess in themselves no mechanical advantage; so that their union is maintained partly by the cartilages interposed between them, and partly by ligamentous and fibrous structures disposed round the articulations.

248. In the movable articulations, or ***diarthrosis*** (*διὰ, through; αϱθϱον, articulation*), as the surfaces are merely in contact with one another, the connexion between the parts is

maintained by means of ligaments and fibrous membranes; for, though cartilages are interposed between their adjacent extremities, they do not form a bond of union between them; on the contrary, they are calculated to facilitate motion, rather than to restrain it. But the muscles which surround the different movable articulations contribute materially to retain the articular surfaces in their natural situations, and to prevent displacement. This is particularly evident in the shoulder-joint, in which the head of the humerus is kept in contact with the glenoid cavity of the scapula not so much by the fibrous capsule, which is weak and loose, as by the surrounding muscles; for if these be weakened by paralysis, luxation may be readily produced. The joints in the extremities are all referable to the movable class; so is that of the lower jaw with the skull, and of the latter with the vertebral column. In the greater number of instances one of the articular surfaces is convex, the other concave; but each of these forms exhibits some varieties of conformation, which are marked by particular names. Thus, an articulating surface, which is rounded and globular, so as to represent a segment of a sphere, is called a *head;* but if it be elongated, the term *condyle* is used. These are in some cases supported by a contracted or thin portion (*neck*), which connects them with the body of the bone. If two condyles be placed in apposition, so as to leave a fossa between them, and constitute a pulley-like surface, it is termed *trochlea.* When plain even surfaces articulate, it is not necessary to mark them by any particular name; in describing them they are referred to generally as articulating surfaces. Some of the articulating depressions have also received names taken from certain peculiarities in their conformation. Thus, the superior extremity of the ulna, which receives the trochlea of the humerus, is called the sigmoid cavity, from some resemblance to the Greek letter Σ (*σιγμα, ειδος, like*); others are denominated from their greater or less degree of depth or shallowness. The deep cup-shaped cavity which receives the head of the femur is called cotyloid (from *κοτυλη, a cup*, and *ειδος, like*); and the shallow oval depression to which the head of the humerus is applied, receives the name of *glenoid* cavity, (from *γληνη, a shallow cavity*, and *ειδος, like*).

The varieties of diarthrosis are:—1. *Enarthrosis* (*εν, in; αρθρον, a joint*), which in common language is called the "ball-

and-socket" joint; such as we see in the hip and shoulder. In these great freedom of motion is provided for.—2. *Arthrodia*, which comprises joints with a limited motion, as in the case of the carpal and tarsal bones, which merely slide for a little way upon each other. The articulations between the tubercles of the ribs and the transverse processes of the vertebræ, and those between the articular processes of the last-named bones, also come under this head.

249. As the extent and form of the articulating surfaces of joints, as well as their ligamentous connexions, vary in different instances, so must their degrees of solidity and mobility: and on a review of the whole of the articulations, it may be laid down as a general principle, that the greater their mobility, the less their solidity; or, in other words, that the one is inversely as the other. All the motions, however, which are admissible in joints may be arranged under four heads, viz. motions of gliding, angular movement or opposition, circumduction, and rotation.

1st. The contiguous surfaces of every movable articulation admit a certain degree of *gliding* motion upon one another, so that it may be regarded as common to all; but in some cases it is the only one which takes place, for instance, between the different bones of the carpus and tarsus. We thus observe that some joints admit of all the motions here indicated; some are deprived of rotation, retaining the rest; whilst in others nothing more than a mere gliding can take place between the surfaces; so that a regular gradation is established in their degrees of mobility between the most movable and those which are least so. The shoulder-joint admits of the greatest extent and variety of movement; those between the carpal and tarsal bones are exceedingly limited in these particulars; and finally, between the latter and those which are altogether immovable, an intermediate grade may be traced, of which the pubic symphysis presents an example.

2nd. The *angular* movement, or opposition, can only take place between long bones. If these be made to move in opposite directions, as from extension to flexion, or from abduction to adduction, they form with one another angles varying in degree according to the extent of the motion. This, in some cases, as in the elbow and knee, is confined to flexion and extension, which makes them strictly ginglymoid or hinge-joints (γιγγλυμος, a hinge); in others the motion is general, and extends to four opposite directions, including each of the points intermediate between them, as may be observed in the shoulder, in the hip, and the metacarpal joint of the thumb, all which joints admit of a circumduction in the part to which they belong.

3rd. The motion of *circumduction* is performed when the shaft of a bone is made to describe a cone, its summit corresponding with the superior articulation, the base being at the inferior extremity of the bone. While this motion is being executed, the limb passes successively through the states of elevation, abduction, depression, adduction, and of course through all the intermediate points; and if a pencil be held between the fingers, and its point applied to any plain surface, such as a wall, it will trace a circle corresponding with the base of a cone, whose summit is at the shoulder-joint, whilst its side coincides with the line described by the out-stretched limb as it traverses the different points just enumerated.

4th. *Rotation* differs altogether from circumduction. In the latter the bone suffers a change of place as it moves from one point to another; in the former, it merely turns on its own axis, and therefore retains the same relative situation with respect to the adjacent parts. This movement, however, admits of two varieties; in one, it is performed on a pivot, as in the motion of the axis on the vertebra dentata; in the other there is a sort of compound motion, for instance, where the radius rolls on its own axis at one end, whilst at the other it moves upon the extremity of the ulna, by which its lower part describes a segment of a circle, and therefore changes place to a certain extent. The femur and humerus also admit of a rotatory motion; in the latter, as the head is closely applied upon the shaft, the axis of motion nearly coincides with that of the bone; but in the former, in consequence of the length of the neck, and of the angle which it forms with the bone, the rotation is performed round an imaginary axis, which may be conceived to pass from the globular head to the condyles.

250. There are but two articulations in which all the motions of opposition, circumduction, and rotation, can be performed, namely, the hip and the shoulder joint. In these a convex

surface is applied to one which is concave, the former being hemispherical, which is essentially necessary to such a freedom of motion. As joints constructed on this principle are more liable to displacement than any others, their security is in a great measure provided for by their being placed at the superior extremity of the limb, by which they are withdrawn from the influence of external forces. This arrangement is made subservient not to the security of the joint solely, but also to a very important purpose in the functions of the limb. For as these free and extended motions are performed in the superior articulation, their effect is communicated to the whole limb, so as to compensate for the more restricted movements in the lower joints.

251. Though all the motions above mentioned take place in the hip and shoulder joints, each of them, considered singly, is not performed with equal facility in both. Thus, circumduction is executed with greater ease in the shoulder than in the hip. Rotation, on the contrary, is more free and perfect in the latter than in the former. Circumduction can be executed with ease only when the axis of motion coincides (or very nearly so) with that of the lever to be moved, as is the case in the humerus; but in the femur, the length of the neck of the bone removes the axis of motion considerably from that of the shaft, and thereby impedes circumduction in proportion as it facilitates the rotation of the limb. These differences of structure in the superior joints of the two extremities bear a direct relation to the conformation of their other articulations, and to the purposes for which they are adapted. For, as the inferior extremity is intended to sustain the weight of the body and for progression, the bones of the leg must be securely fixed, which could be effected only by diminishing their mobility; on this account no rotation or supination is allowed between the tibia and fibula; but, to compensate for this deficiency, rotation is permitted in the hip. But as the superior extremity, on the contrary, is fitted for the prehension of objects, and for quick and varied movements, free motion is allowed between the bones of the fore-arm, and between the latter and the carpus, in order that the hand and fingers may be more readily directed and applied to such objects as are required to be seized for different

purposes; and the power of pronation and supination, thus conferred, more than compensates for any deficiency in the rotatory motion of the humerus.

252. It has been already observed, that rotatory motion in a bone presupposes the existence of a globular head, placed so that its axis shall form an angle with the shaft. Wherever this requisite is wanted, motion is confined to opposition and circumduction, as occurs in the articulation of the thumb with the carpus, in the phalanges with the metacarpal bones, and in the clavicle with the sternum. In these joints, the articulating surfaces are placed at the ends of the more movable bones; and as their axes coincide with that of motion, rotation is prevented; but circumduction and opposition are freely performed. When these are limited in extent, as in the sterno-clavicular articulation, it arises rather from the accessory ligaments of the part than from any impediment in the surfaces of the bones; and if motion in one direction be more free than in another, as in the digital phalanges with the metacarpus, where flexion and extension are more free than abduction and adduction, it proceeds partly from the existence of the lateral ligaments, and partly from the great power possessed by the flexor and extensor muscles compared with those which perform the other movements. Though in the knee and elbow the axis of motion coincides with that of the bones, yet their movement is confined to two directions, viz. to flexion and extension. In these joints, all other motions besides those just mentioned are prevented by the breadth of the articulating surfaces, and by their mode of adaptation: however, when they are flexed, some degree of lateral motion, and also of circumduction, can be performed; as any individual may ascertain by resting his elbow on a table, when he will find that the fore-arm may be made to describe a cone with its summit at the olecranon and base towards the fingers.

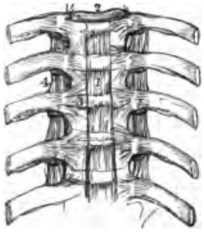
ARTICULATIONS OF THE SPINE.

253. The different pieces of the vertebral column are connected together by ligaments, by fibro-cartilage, and in some parts by synovial membranes; the former serving to retain them in their situation, the latter to facilitate motion between the

different bones. The bodies are joined by two ligamentous bands, extending the whole length of the chain, and also by the inter-vertebral substances.

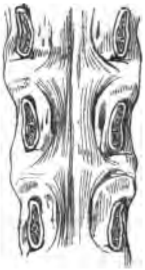
i. The *anterior common ligament*, fig. 62, 1, (ligamentum commune anterius, Sœmmering; fascia longitudinalis anterior, Weitbrecht,) is a strong band of fibres which is placed on the front of the bodies of the vertebræ, and reaches from the axis to the first bone of the sacrum, becoming broader as it descends. It consists of longitudinal fibres which are dense, firm, and well-marked. The superficial fibres extend from a given vertebra to the fourth or fifth below it; the set subjacent to these passes from the body of one to about the third beneath it; whilst the deeper ones pass only from one vertebra to that next it. The fibres are thicker towards the middle of the bodies of the vertebræ than at their margins, or over the inter-vertebral cartilages; by which means their transverse depressions are filled up, and the surface of the column rendered even. It may also be observed that they adhere more closely to the margins of the bones than to the middle of their bodies, and still more closely to the inter-vertebral cartilages. Upon the sides of the vertebræ, there are some fibres which are thin and scattered, and reach from one bone to the other.

Fig. 62.



ii. The *posterior common ligament*, fig. 63, (ligamentum commune posterius, Sœmm.; fascia longitudinalis postica, Weit.) is situated within the spinal canal, and attached to the posterior surface of the bodies of the vertebræ, extending from the axis to the sacrum. It is smooth, shining, and broader opposite the inter-vertebral cartilages than opposite the bodies of the bones, so that its margins present a series of points or dentations with intervening concave spaces. In the greater part of its extent it adheres firmly to

Fig. 63.



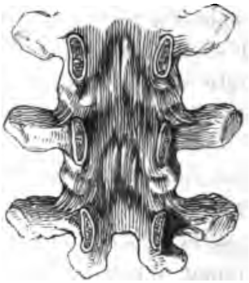
the fibro-cartilages and to the bodies of the vertebræ, and is separated by loose cellular tissue from the prolongation of the dura mater which lines the canal.

iii. The *inter-vertebral substance* (ligamenta inter-vertebralia, Weit.) is a plate or disc of fibro-cartilage, fig. 62, 2, placed between the bodies of each pair of vertebræ, from the axis to the base of the sacrum. They correspond in shape to the parts of the vertebræ between which they are interposed, and, like them, increase in thickness from the upper to the lower end of the column. The thickness of these plates is not, however, uniform in their entire circumference. As they contribute to the production and maintenance of the curves which naturally exist in the spine, they are thinnest anteriorly, in the dorsal region, where its concavity looks forward, and, on the contrary, thicker in front, in the neck and loins, where the convexity of the column looks in that direction. They are covered anteriorly and posteriorly by the common ligaments which are intimately adherent to them; in the dorsal region they are connected laterally, by short ligaments, to the heads of all the ribs, which articulate with two vertebræ. The inter-vertebral substance is composed, towards its circumference, of thin plates of fibro-cartilage, resting on their edges, and placed one within the other, as it were, concentrically. Thus the outer plate like a rim runs round the disc, its lower edge resting on the vertebra beneath it; its anterior or convex surface being subjacent to the anterior common ligament, whilst its concave surface is in apposition with the plate next within it. They are not however so broad as that their upper edges may reach the vertebra above them, nor are they exactly perpendicular; they incline inwards a little, so as to allow other plates to be in a manner piled upon them: each cartilage being in fact composed of two or three tiers of very narrow plates thus disposed. The interstices between the plates are filled by a pulpy and apparently elastic substance; and as the number of the plates gradually decreases towards the centre, whilst the pulpy matter increases, the quantity of the latter is such, that when the pressure which confines it is taken off by cutting through the inter-vertebral substance, it will rise up so as to assume a conical form.

254. The *articulating processes* of the vertebræ are con-

nected by irregular fibrous bands (ligamenta processuum obliquorum, Weit.), forming a capsule outside the synovial membranes. These are longer and more loose in the cervical than in the dorsal or lumbar regions.

Fig. 64.



255. The arches, or plates of the vertebræ, are connected by the *ligamenta subflava*, fig. 64, (ligamenta vertebrarum subflava, Weit.) as their bodies are by the inter-vertebral cartilages. These consist of yellow elastic fibres, almost perpendicular in their direction, as they pass from the inferior border of one arch to the adjacent border of that immediately below it. They extend from the root of the transverse processes at each side backwards to the point where the two arches converge at the origin of the spinous processes, where the margins of each lateral half of the ligament may be observed to be merely in contact. The superior border of the ligament is attached, not to the margin exactly of the arch, but rather higher up on its anterior surface; whilst the inferior border is prolonged a little on the posterior surface, as well as the margin of its corresponding arch. They do not exist between the occiput and the atlas, or between the latter and the axis; common fibrous membrane supplies their place in these two spaces. They are most distinctly seen when the pedicles and arches are detached from the bodies of the vertebræ, so that they may be viewed from within the theca vertebralis as in this drawing. At the posterior aspect of the spine they appear short, and, as it were, overlaid by the arches. See fig. 72, 3; lower down, the position of the inter-spinous ligaments is indicated, 2.

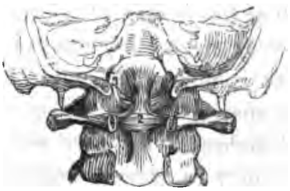
256. The *articulation of the spinous processes* is effected by means of the supra-spinous and inter-spinous ligaments. 1. The *supra-spinous ligament* consists of small, compressed bundles of longitudinal fibres, which connect the summits of the spinous processes, and form a continuous chain from the seventh cervical vertebra to the spine of the sacrum. See fig. 72, 1. The posterior fibres pass down from a given vertebra to the third

or fourth below it; those more deeply seated reach only from one to the next, or the second beneath it. 2. The *inter-spinous ligaments,* thin and rather membranous, extend from the root to near the summit of each spinous process, connecting the inferior border of one with the superior border of that next below it. They exist in the dorsal and lumbar regions only, and are intimately connected with the extensor muscles of the spine. The *inter-transverse ligaments* are found only between the transverse processes of the inferior dorsal vertebræ, and even there very indistinctly, for they are united so intimately with the sacro-lumbalis muscle, that their fibres are quite confused.

Articulations of the two upper vertebræ.

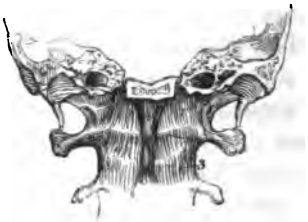
257. The articulation of the axis with the atlas is effected by means of their articulating processes, also (in the place of inter-vertebral substance, which would be altogether incompatible with the requisite movements) by the odontoid process of the former, which is connected in a particular manner with the arch of the latter, and constitutes the pivot on which the head turns in its rotatory motions. There are three ligaments and four synovial membranes in this articulation.

Fig. 65.



The *transverse ligament,* fig. 65, 2, (ligamentum atlantis transversum, Weit. Sœmm.) is a strong, thick fasciculus of fibres, compressed from before backwards, arched in its direction, and attached on each side to the inner border of the superior articulating processes of the atlas. It is broader and thicker at the middle than at its extremities. From the middle of its posterior surface a short thin bundle of fibres passes down to be attached to the root of the odontoid process, whilst another passes up to the basilar process. These appendages form a cross with the transverse ligament, and serve to bind the occiput to the two first vertebræ; from this is derived the term *cruciform,* which is sometimes applied to the transverse ligament. To bring these structures into view, the posterior part of the vertebral arches must be removed, as indicated in this drawing.

Fig. 66.



The *anterior atlo-axoid ligament* passes from the border of the anterior arch of the atlas, and its tubercle, to the body of the axis and the root of its odontoid process. It is thin and membranous, fig. 66, 3.

The *posterior atlo-axoid ligament* connects the posterior arch of the atlas with the plates of the axis, fig. 67, 2. Thus the interstices between the plates or arches, which in all the other vertebræ are filled by the ligamenta subflava, are occupied by a loose membrane between the second and first, as well as between the latter and the occiput, 1. The edges of the articulating processes are connected by irregular fibres passing from one to the other.

Two synovial membranes are placed between the articulating processes of the atlas and axis. One between the odontoid process and the transverse ligament, another between it and the arch of the atlas.

ARTICULATIONS OF THE CRANIUM.

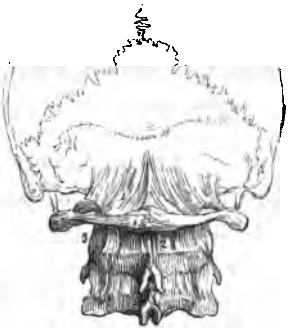
258. The cranium is articulated, 1, with the atlas; 2, with the axis; 3, with the lower jaw.

259. The articulation of the cranium with the atlas takes place between the condyles of the occipital bone and the superior articulating processes of that vertebra, which are connected by ligaments and synovial membranes; it is also connected with the same by the two following ligaments.

The *anterior occipito-atloidean ligament*, fig. 66, 1, (membrana annuli anterioris vertebræ primæ,) extends from the anterior border of the occipital foramen, between the condyles, to the margin of the arch of the atlas between its superior articulating processes. This is thin, broad, and membranous; but in the median line, a sort of accessory ligament, 2, is placed in front of it, which is thick, round, and composed of vertical fibres, attached above to the surface of the basilar process, and below to the small tubercle on the front of the atlas. The anterior surface of these ligaments is covered by the recti antici muscles, the posterior covers the odontoid process and its ligaments.

The *posterior occipito-atloidean ligament*, fig. 67, 1, also broad and membranous, is attached superiorly to all that part of the margin of the occipital foramen which is behind the condyles, and inferiorly to the adjacent border of the posterior arch of the atlas. It consists of two lamellæ, which are united at their superior attachment, but soon divide, one becoming blended with the dura mater, which lines the vertebral canal, whilst the other is inserted into the arch of the atlas. The posterior surface of the ligament is in apposition with the posterior recti and superior oblique muscles, the anterior looks towards the vertebral canal; at each side, near the articular processes, the ligament forms part of the foramina through which the sub-occipital nerves and vertebral arteries pass.

Fig. 67.

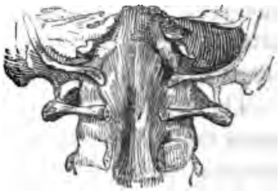


260. The articulation of the occipital bone with the axis is effected through the medium of ligaments, as no part of their surfaces comes into contact.

The *odontoid ligaments*, fig. 65, 3, (ligamenta alaria) are two thick bundles of fibres attached below to each side of the summit of the odontoid process, and passing up diverging to be implanted into the rough depressions at the inner side of the condyles of the occiput, and also to a small part of the margin of the occipital foramen. Their direction, therefore, is obliquely upwards and outwards; the triangular interval which they thus leave is filled by some thin fibres passing almost perpendicularly from the margin of the foramen to the summit of the process. These are strictly check ligaments; the middle set, last described, prevent what may be termed a retroversion of the head, whilst the lateral pair check its rotatory motions.

The *occipito-axoidean ligament*, fig. 68, seems to be a prolongation of the posterior common ligament; it is attached above to the inner surface of the basilar groove, from which

Fig. 68.

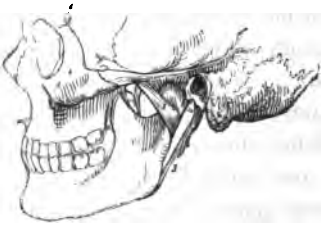


it descends perpendicularly, becoming narrow, and opposite the axis is blended with the posterior common ligament. It covers the odontoid process and its check ligaments, and is intimately connected with the transverse ligament.

ARTICULATION OF THE LOWER JAW.

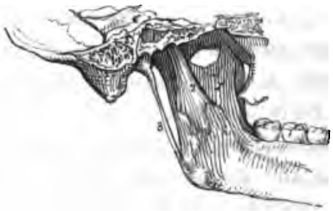
261. The lower jaw articulates at each side by one of its condyles with the glenoid cavity in the temporal bone; hence it is called the temporo-maxillary articulation. By means of an inter-articular cartilage a double joint is formed at each side, with distinct synovial membranes.

Fig. 69.



The *external lateral ligament*, fig. 69, 1, is a short fasciculus of fibres, attached above to the external surface of the zygoma, and to the tubercle at the bifurcation of its root; below, to the external surface and posterior border of the neck of the condyle, its fibres being directed downwards and backwards. Externally it is covered by the parotid gland, internally it is in relation with the inter-articular cartilage and synovial membranes.

Fig. 70.

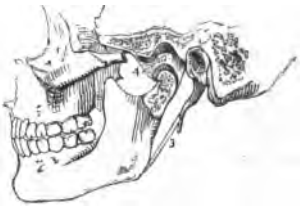


The *internal lateral ligament*, fig. 70, thin, loose, and elongated, extends from the spinous process of the sphenoid bone downwards, and a little forwards, to be attached to the inferior maxillary bone at the lower border of the dental foramen, where it is somewhat expanded. Its external surface is in relation superiorly with the external pterygoid muscle, and in the rest of its extent with the ramus of the jaw, from which it is separated by the internal maxillary artery and dental nerve. Its inner surface is concealed by the internal pterygoid muscle.

The *stylo-maxillary ligament*, figs. 69, 70, 71; 3, thin and aponeurotic, passes from near the point of the styloid process to the inferior border of the angle of the jaw, where it is inserted between the masseter and internal pterygoid muscles.

The *inter-articular fibro-cartilage*, fig. 71, 4, is a thin plate, placed horizontally between the articular surfaces of the bones; it is of an oval form, and somewhat thicker at its margins than at its centre, where it is sometimes perforated. Its inferior surface, which is in contact with the condyle, is concave; the superior is alternately concave and convex when taken from before backwards, conforming in some way with the outline of the articular cavity. Its circumference is connected at the outside with the external lateral ligament, and anteriorly with the external pterygoid muscle.

Fig. 71.



The synovial membrane, after lining the superior surface of the inter-articular cartilage, is reflected upwards on the external lateral ligament, and over the smooth part of the glenoid cavity; a similar membrane is interposed between the inferior surface of the cartilage and the condyle, so as to constitute a double joint.

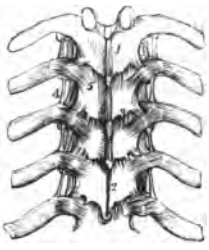
ARTICULATIONS OF THE RIBS.

262. The ligaments of the ribs may be divided into three sets: those which connect them—1, with the bodies of the vertebræ; 2, with their transverse processes; 3, with the sternum.

The *costo-vertebral ligaments* (lig. capitulorum costarum) consist: 1. Of an anterior ligament which connects the head of each rib with the sides of the bodies of the vertebræ, fig. 62, 3; its fibres, flat and radiated, are divided into three bundles, of which the middle one passes horizontally forwards upon the corresponding inter-vertebral cartilage, whilst the superior ascends to the body of the vertebra above it, and the inferior descends to that below. From the divergence of its fibres, this is usually called the *stellate ligament*. 2ndly. Of an *inter-articular ligament*, which is a thin and short band of fibres which passes transversely from the ridge separating the two articular surfaces on the head of the rib to the inter-vertebral substance, and dividing the articulation into two parts, each lined by a separate synovial membrane. This ligament does not exist in the articulation of the first, eleventh, or twelfth ribs, and in consequence there is in them but one synovial capsule.

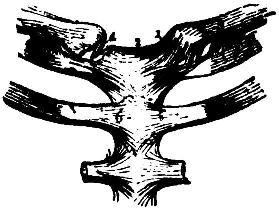
The *costo-transverse ligaments* connect the tubercles of the ribs with the transverse processes of the vertebræ; from their position they are named posterior, middle, and anterior. 1. The *posterior costo-transverse ligament*, fig. 72, 5, (lig. transversum externum costarum, Weit.) consists of a very short thick fasciculus of fibres which passes from the posterior surface of the summit of the transverse process, to the rough unarticulated part of the tubercle of the rib. Those of the superior ribs ascend, those of the inferior descend somewhat. 2. The *middle costo-transverse ligament* consists of a series of very short parallel fibres, which unite the neck of the rib to the anterior surface of the contiguous transverse process. These fibres are seen by removing horizontally a portion of the rib and transverse process, and forcibly drawing one from the other. 3. The *anterior costo-transverse ligament*, figs. 62, 72; 4, (lig. transversum internum costarum, Weit.) is usually divided into two fasciculi of fibres, both nearly in apposition, and on the same plane. They pass from the neck of the rib obliquely upwards and outwards to the lower margin of the transverse process next above it. These do not exist in the articulations of the first and last ribs. The articulations between the tubercles of the ribs and the transverse processes are provided with synovial capsules.

Fig. 72.



The *costo-sternal articulations*, situated between the anterior extremities of the cartilages of the ribs and the fossæ, in the margins of the sternum, are covered and supported by, 1, an anterior set of ligamentous fibres, fig. 73, 6, thin, scattered, and

Fig. 73.



radiated, passing from the extremity of the cartilage to the anterior surface of the sternum, where they interlace with those of the opposite side, and are blended with the aponeurosis of the pectoralis major muscle; 2, a posterior set of fibres similarly disposed, but not so thick or numerous, connecting the thoracic surfaces of the same parts; 3, a synovial membrane, interposed between the ends of each true rib and the sternum, and also between the margins of each pair of false ribs, where they articulate with one another. These can be readily demonstrated by slicing off a little of the anterior surface of the sternum and cartilages. A thin fasciculus of fibres connects the cartilage of the seventh rib with the xiphoid cartilage, and thence called the *costo-xiphoid ligament.* The pieces of the sternum are connected by a layer of fibro-cartilage placed between their contiguous borders; and, on the anterior and posterior surfaces, some scattered ligamentous fibres may be observed running longitudinally, which serve to strengthen their connexion. These are sometimes called the anterior and posterior sternal ligaments.

ARTICULATIONS OF THE SUPERIOR EXTREMITIES.

263. These may be arranged under the following heads, taking them in their anatomical order, from above downwards: 1, the articulation between the sternum and clavicle; 2, that of the scapula and humerus; 3, of the elbow; 4, of the wrist; 5, of the hand; 6, of the fingers.

The superior extremity has but one point of bony attachment to the trunk, namely, that at the sterno-clavicular articulation, the scapula being connected with the trunk by muscles only. The clavicle articulates with the first bone of the sternum, and is connected with its fellow of the opposite side, and the first rib, by ligaments.

264. The *sterno-clavicular* articulation consists of an anterior and posterior ligament, an inter-articular cartilage, and two synovial membranes.

The *anterior sterno-clavicular ligament*, fig. 78, 1, passes from the inner extremity of the clavicle, downwards and inwards, upon the surface of the sternum. It is broad, and consists of parallel fibres, and corresponds, internally, with the synovial membranes of the articulation, and with the inter-articular cartilage to which it is adherent; externally, with the sternal origin of the sterno-mastoid muscle.

The *posterior sterno-clavicular ligament*, of similar conformation with the last, but not so broad or strongly marked, is placed between the same bones lying at the thoracic aspect of the joint. Its posterior surface is in relation with the sterno-hyoideus and sterno-thyroideus muscles.

The *inter-articular fibro-cartilage*, 4, nearly circular in its form, and thicker at its border than at the centre, is interposed between the articulating surfaces of the sternum and clavicle. Towards its superior and posterior part it is attached to the margin of the clavicle, and at the opposite point to the cartilage of the first rib. In the latter situation it is thin and somewhat prolonged, so that the inferior border of the clavicle rests upon it.

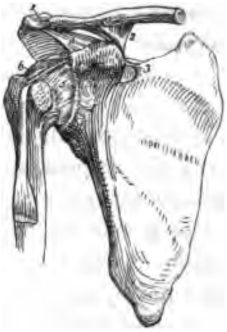
Synovial membranes.—In this articulation, as in that of the lower jaw, there are two synovial membranes, of which one is reflected over the sternal end of the clavicle and adjacent surface of the fibro-cartilage, the other is disposed similarly between the cartilage and the articulating surface of the sternum.

The *inter-clavicular ligament*, 2, is a dense fasciculus of fibres, placed transversely between the contiguous extremities of the clavicles. Its fibres do not pass directly across from one to the other; they dip down, and are attached to the upper margin of the sternum, by which it is rendered concave from side to side.

The *costo-clavicular ligament*, 3, (ligamentum rhomboides, Weit. Sœmm.) does not properly form part of the articulation; yet it contributes materially to retain the clavicle in its situation. It is attached inferiorly to the cartilage of the first rib near its sternal end, and passes obliquely backwards and upwards, to be fixed to a roughness at the under surface of the clavicle.

265. The *scapulo-clavicular articulation* is effected between the acromion process of the scapula and the external end of the

Fig. 74.



clavicle. These points are connected, 1st, by a *superior ligament*, fig. 74, 1, which is a strong broad band of fibres, passing from the superior surface of the acromion to the adjacent extremity of the clavicle; 2ndly, by an *inferior ligament* similar to the preceding, and placed at the under surfaces of the same bones; 3rdly, by a synovial membrane lining the two articular surfaces of the bones. As there is an inter-articular cartilage, there are sometimes two narrow synovial sacs, disposed in the same way as those in the sterno-clavicular articulation.

The *coraco-clavicular ligament*, fig. 74, 2, which connects the clavicle with the coracoid process of the scapula, presents two parts, each marked by a particular name. There is, however, no division between them, nor other distinction than that they look different ways.

The *posterior* or *internal fasciculus*, (conoid ligament,) broad above, narrow below, is attached, inferiorly, to the root of the coracoid process; superiorly to a rough space at the inferior surface of the clavicle, its fibres being directed backwards and upwards. The *anterior* or *external fasciculus* (trapezoid ligament) passes from the superior surface of the coracoid process upwards, to an oblique line extending outwards from the tuberosity into which the conoid ligament is inserted; with the latter it unites at an angle, one of its aspects being directed forwards and upwards, the other downwards and backwards.

266. There are two ligaments proper to the scapula: 1. The *coracoid ligament*, 3, (ligamentum proprium posterius,) is a thin flat band of fibres, attached by its extremities to the opposite margins of the notch at the root of the coracoid process, which it thus converts into a foramen for the transmission of the supra-scapular nerve, the artery most commonly passing external to it. 2. The *coraco-acromion ligament*, 4, (ligamentum proprium anterius,) is a broad, firm, triangular fasciculus, attached by its broader extremity to the coracoid process, and by

the narrower to the acromion, between which it is stretched almost horizontally. Its inferior surface looks downwards upon the shoulder-joint, the superior is covered by the deltoid muscle.

THE SHOULDER-JOINT.

267. The globular head of the humerus and the glenoid cavity of the scapula are the osseous parts which compose this articulation (*scapulo-humeral*). As the head of the humerus is large and prominent, whilst the cavity is merely a superficial depression, it must be evident that they are retained in their situation not by any mechanical contrivance, but by the capsular ligament, and the muscles which are attached to the two tuberosities of the humerus.

268. The *capsular ligament*, fig. 74, 5, is attached superiorly round the margin of the glenoid cavity, and inferiorly round the neck of the humerus. It is broader in the latter than in the former situation; and its laxity is such, that if the muscular connexions of the humerus be detached, this bone drops away from the glenoid cavity. The superior and inner part of this membrane is covered and strengthened by a bundle of fibres, 7, passing outwards and forwards from the coracoid process to the great tuberosity of the humerus (*coraco-humeral ligament*). Besides this, it receives additions from the tendons of the supra and infra spinatus muscles, from the teres minor and sub-scapularis, which are intimately connected with it, as they proceed to be attached to the tuberosities of the humerus. Thus its superior part is thick and firm, the inferior comparatively thin and weak. Its internal surface is lined by the synovial membrane; the external, besides the muscles already mentioned, is covered by the deltoid; inferiorly, it is in relation with the long head of the triceps and the circumflex vessels. The insertion of its inferior border is interrupted to give passage to the long tendon of the biceps muscle.

269. The *glenoid ligament* appears to be continuous with the tendon of the long head of the biceps muscle: this at its point of attachment to the superior margin of the glenoid cavity, separates into two sets of fibres, which, after encircling it, meet and unite inferiorly. These fibres, by elevating the border of the cavity, render it a little deeper.

270. The *synovial membrane* lines the glenoid cavity, and is reflected over its lower margin until it reaches the inner surface of the fibrous capsule, on which it is prolonged as far as the neck of the humerus, where it separates from the capsule, and is applied upon the articular surface of the head of that bone, giving it a smooth investment. Viewed in this way, it appears a simple shut sac; and such it would be but for the peculiar relation of the long tendon of the biceps muscle to the shoulder-joint. The tendon is in fact enclosed in a tubular sheath, formed by an offset or process of the synovial membrane, which is reflected upon it where it is about to pass through the fibrous capsule, and is thence continued up to the summit of the glenoid cavity, where it is continuous with that part of the membrane which invests it. By this provision the integrity of the articulation and of the membrane is preserved.

On the superior and external surface of the capsule a considerable bursa mucosa is situated, by means of which the contiguous surfaces of the coracoid and acromion processes, and of the coraco-acromion ligament, are rendered smooth and lubricated, to facilitate their movements on the subjacent capsule.

271. The *coraco-humeral*, or accessory ligament, 6, above noticed, extends obliquely over the upper and outer part of the articulation; it is attached to the coracoid process, and thence descends, intimately connected with the capsule, to the greater tuberosity of the humerus.

THE ELBOW-JOINT.

272. The lower extremity of the humerus is connected with the ulna and radius at the elbow, so as to form a hinge-joint. The sigmoid cavity of the ulna articulates with the trochlea of the humerus, so as to admit of flexion and extension only, while the cup-shaped depression on the head of the radius can turn freely on the rounded tuberosity to which it is applied. The bones are connected by four ligaments and a synovial membrane.

273. The *internal lateral ligament*, fig. 75, 1, composed of diverging and radiated fibres, presents two parts, each with a different aspect, one looking obliquely forwards, the other backwards. The anterior part is attached above, where it is narrow

and pointed, to the front of the internal condyle of the humerus; its fibres, as they descend, become broad and expanded, and are inserted into the coronoid process, along the inner margin of the sigmoid cavity. The posterior part, of the same form (triangular), passes from the under and back part of the same process of bone downwards to the inner border of the olecranon; the superior fibres of this portion extend transversely between the points just named, the rest become successively more and more oblique.

Fig. 75.

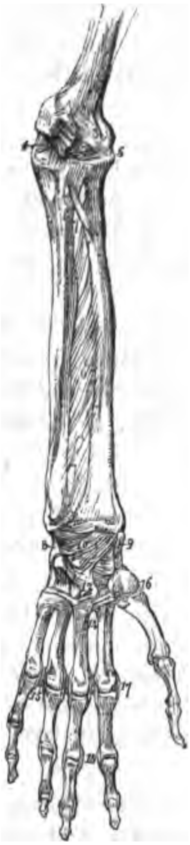
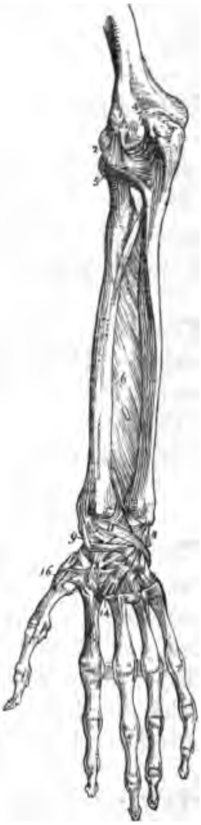


Fig. 76.



274. The *external lateral ligament*, fig. 76, 2, shorter and much narrower than the internal, is attached superiorly to the external condyle of the humerus, and inferiorly becomes blended with the annular ligament of the radius; none of its fibres are prolonged to the surface of that bone, for if they were they would check its rotatory motion. It is intimately connected with the tendinous attachment of the extensor muscles, on which account, when dissected, it presents a jagged, irregular appearance.

275. The *anterior ligament*, fig. 75, 3, is a broad thin membrane, placed in front of the joint, extending from the rough margin of the fossa, which receives the coronoid process during flexion, downwards to the anterior border of the coronoid process, and to the annular ligament of the radius. Some of its fibres are directed obliquely downwards and outwards, others are vertical.

276. The *posterior ligament*, fig. 76, 4, loose and weak, consists of fibres proceeding in opposite directions; thus some pass transversely between the adjacent margins of the fossa which receives the head of the olecranon; whilst others, subjacent to these, but not very well marked, pass vertically from the superior concave margin of that fossa to the extremity of the olecranon.

Though these structures are described and named as separate ligaments, it will be found, on examination, that they form a continuous membrane placed round the joint, as fibrous capsules usually are, except only that the irregularity of the surfaces to which they are attached prevents their continuity from being readily perceived, and gives them the appearance of distinct ligamentous connexions passing from one point of bone to another.

The upper Radio-ulnar articulation.

277. The head of the radius articulates with the small sigmoid cavity of the ulna, on which it rolls when it is made to turn on its axis. These surfaces are covered with cartilage, and invested by the synovial membrane of the elbow-joint. The radius is connected to the ulna by an annular ligament.

The *annular* or *orbicular ligament*, figs. 75, 76; 5, is a strong band of circular fibres, which, by being attached to the borders of the small sigmoid cavity, forms a ring, encircling the head of the radius, and binding it firmly in its situation. Its external surface is in apposition with the external lateral ligament of the elbow, whose fibres are inserted into it; the internal is smooth and lined by the synovial membrane.

278. The *synovial membrane* of the elbow-joint, after having covered the articular extremity of the humerus, is prolonged a little on the anterior surface of that bone, as far as the attachment of the anterior ligament, where it is reflected, and applied to the internal surface of that membrane, lining it as far as its radio-cubital insertion; at that point the synovial membrane leaves the fibrous one, and invests the articular surfaces of the radius and ulna, and is extended over them until it comes into apposition with the posterior ligament, by which it is guided to the extremity of the humerus; in the same way, it lines the lateral ligaments. Besides these reflections, the membrane forms two pouches, one by being prolonged into the small sigmoid cavity, the other where it passes between the annular ligament and the contiguous surface of the head of the radius.

When the joint is laid open, and the bones extended, it will be observed that the head of the radius is not in contact with the rounded articulating process of the humerus. On which account, in the extended state of the limb, the rotatory motions of this bone are performed with much less ease than in that of flexion, from its wanting support at its upper end. The part of the humerus here referred to is moreover covered with cartilage only on its anterior aspect, indicating that the radius moves on it only when in the flexed position.

The middle Radio-ulnar articulation.

The interval between the radius and ulna in the fore-arm is filled up by an inter-osseous ligament and a round ligament, which serve to connect them together, and form what is called the middle radio-ulnar articulation.

279. The *inter-osseous ligament*, figs. 75, 76; 6, (membrana inter-ossea,) is a thin, flat, fibrous membrane, the direction of its fibres being obliquely downwards and inwards, from the inner sharp border of the radius to the contiguous one of the ulna. It does not reach the whole length of the bones, as it commences about an inch below the tubercle of the radius. The surfaces of this membrane are intimately connected with the deep-seated muscles of the fore-arm, serving to increase their points of origin

as well as to connect the bones. Inferiorly, it leaves an opening for the transmission of the anterior inter-osseous vessels; superiorly, there is another, but much larger interval, through which the posterior inter-osseous vessels pass.

280. The *round ligament*, fig. 75, 7, in some measure supplies the deficiency left by the inter-osseous ligament at the superior part of the arm. It is a thin narrow fasciculus of fibres, extending obliquely from the coronoid process, downwards and outwards, to be attached to the radius, about half an inch below its tubercle. The direction of its fibres is therefore altogether different from that of the fibres of the inter-osseous ligament.

The lower Radio-ulnar articulation.

281. At the lower or carpal ends of the radius and ulna, the former rotates on the latter as its point of support, the articulating surface of the radius being concave, that of the ulna convex. The bones are connected anteriorly and posteriorly by some fibres passing between their extremities, so thin and scattered as scarcely to admit or require description, but internally they are joined by a fibro-cartilage and a synovial membrane.

282. The *fibro-cartilage*, placed transversely between the bones, is attached by its base to a rough line separating the carpal from the ulnar articulating surface of the radius, and by its summit to a depression at the root of the styloid process of the ulna. Its superior surface looks towards the head of the ulna, the inferior to the cuneiform bone; both are smooth, and lined by synovial membrane; the inferior one by the large membrane of the wrist-joint, the superior by a small one peculiar to the radio-ulnar articulation. Its two borders are connected with the carpal ligaments. As the radius rolls on the ulna, this cartilage is carried with it, and forms its chief bond of union with the latter bone.

The *synovial membrane* is frequently called *membrana sacciformis*, though there is nothing in its conformation which distinguishes it from other synovial sacs. It may be considered as presenting two parts, one projecting perpendicularly upwards into the articulation of the radius and ulna, lining the contiguous surfaces of each; the other placed horizontally between the head of the ulna and the corresponding surface of the fibro-cartilage, lining them also; both, however, are formed by a continuous membrane.

THE WRIST-JOINT.

283. This articulation (*radio-carpal*) is formed above by the radius and triangular fibro-cartilage, and the first three bones of the carpus below. The articular aspect of the former, when viewed in the fresh state, presents an oval and slightly concave surface, its greatest breadth being from side to side. The surface of the radius is divided into two parts, by a line extending from before backwards; so that these, together with the cartilage, present three articular surfaces, one for each carpal bone. The scaphoid, semi-lunar, and cuneiform bones are articulated together, so as to form a rounded convex surface, which is received into the concavity above described. Four ligaments and a synovial membrane retain these parts in their situation, as follow:—

284. The *internal lateral ligament*, figs. 75, 76; 8, passes directly downwards, from the extremity of the styloid process of the ulna, to be attached to the cuneiform bone; it also sends some fibres to the anterior annular ligament and the pisiform bone. Its form is that of a rounded cord; its inner surface is in contact with the synovial membrane of the radio-carpal articulation.

285. The *external lateral ligament*, 9, extends from the styloid process of the radius to a rough surface on the outer side of the scaphoid bone, some of its fibres being prolonged to the trapezium, and also to the annular ligament of the wrist.

286. The *anterior ligament*, 10, (*radio-carpal*,) broad and membranous, is attached to the rough border of the carpal extremity of the radius, and to the base of its styloid process, from which its fibres pass down to be inserted into the anterior surface of the scaphoid, semi-lunar, and cuneiform bones. It is pierced by several foramina for the transmission of vessels: one of its surfaces is lined by the synovial membrane of the joint, the other is in contact with the tendons of the flexor muscles.

287. The *posterior ligament*, 11, extends obliquely downwards and inwards, from the extremity of the radius to the posterior surface of the semi-lunar and cuneiform bones; its fibres appear to be prolonged for some way on the carpal bones. One surface is in contact with the synovial membrane, the other with the extensor tendons.

The *synovial membrane*, after having lined the articular surface of the radius, and the triangular fibro-cartilage, is reflected on the anterior and posterior ligaments, and thence over the surface of the carpal bones.

ARTICULATIONS OF THE CARPAL BONES.

288. The bones of the carpus consist of two sets, each united by its proper connexions, so as to form a row; and the two rows are connected by fibrous bands and a synovial membrane, so as to form between them a joint. The connexions proper to the first row are inter-osseous fibro-cartilages, and ligaments placed on their dorsal and palmar surfaces.

The *inter-osseous fibro-cartilages* are two lamellæ, one placed at each side of the semi-lunar bone, connecting it with the scaphoid and cuneiform bones. The carpal extremity of these is smooth, and lined by the synovial membrane of the wrist-joint.

289. The *palmar ligaments* are two, one extending from the scaphoid bone to the semi-lunar, the other from the semi-lunar to the cuneiform, their direction being transverse, and as their fibres are partly united, they may be considered as a continuous band connecting these bones.

290. The *dorsal ligaments* are also two, disposed similarly and connecting the same bones on their posterior surfaces. The pisiform bone stands out of the range, and rests on the palmar surface of the cuneiform, with which it is articulated by an irregular fibrous capsule and a synovial membrane.

291. The carpal bones of the second range are also connected by similar means. Three *dorsal and palmar ligaments* pass transversely from one bone to the other. There are, however, but two *inter-osseous fibro-cartilages*, placed one at each side of the os magnum, connecting it with the trapezoid externally, and the unciform internally. Such are the means of connexion peculiar to each row.

292. The ligaments which connect the upper to the lower row of bones are placed at their palmar, dorsal, and lateral aspects.

The *lateral ligaments* are placed one at the radial, the other at the ulnar border of the carpus; the former connects the scaphoid bone with the trapezium, the latter the cuneiform with the unciform.

The *palmar* or *anterior ligament* consists of short fibres, which pass obliquely from the bones of the first to those of the second range. The *posterior* is similar in structure and arrangement.

Synovial membrane. — It may be observed, that the first range of carpal bones forms a concavity; the second, particularly the os magnum and unciform, a convexity, which is received within it: by these means a ball-and-socket joint is formed, which is completed by a synovial membrane reflected over the articular surfaces of the different osseous pieces which compose it. The membrane, moreover, sends two processes between the three bones of the first row, and three between those of the second, so as to facilitate their respective motions.

CARPO-METACARPAL ARTICULATIONS.

293. The last four metacarpal bones are connected with those of the carpus by means of two sets of fibrous bands, situated, one on the palmar, fig. 75, 12, the other on the dorsal surface, fig. 76, 13, the latter being better marked. All but the fifth metacarpal bone receive two bands. Thus, to the second, or that of the fore-finger, a thin fasciculus of fibres passes from the trapezium, another from the trapezoid bone; the third receives one from the latter, and also from the os magnum; the fourth from the os magnum and also from the unciform; but the fifth is connected to the latter only. On the palmar surface a similar mode of connexion exists, but the fibres are not so well defined.

294. The *carpal extremities* of the last four metacarpal bones are bound together by three transverse fibrous bands, 14, on the palmar, and the same on the dorsal surface, passing from one to the other; they are slight, and often ill-defined.

295. The *digital extremities* of these metacarpal bones are connected at their palmar aspect by a flat band passing across them, and closely connected with the head of each; this is called the *transverse ligament;* its place is indicated, fig. 75, 15; but it is better shown, though not numbered, in fig. 76, at the metacarpo-phalangal joints.

296. The *metacarpal bone of the thumb* is articulated on quite a different principle from the others; for, as it admits of all the motions except rotation, it is connected to the trapezium by a capsular ligament, 16, which passes from the rough border bounding its articular surface to the trapezium: these parts are lined by a synovial membrane.

ARTICULATION OF THE PHALANGES WITH THE METACARPAL BONES.

297. The rounded head of each of the last four metacarpal bones being received into the slight concavity situated in the extremity of the first phalanx, is maintained *in situ* by two lateral ligaments, an anterior ligament, and a synovial membrane.

298. The *lateral ligaments* consist of dense fasciculi of fibres, fig. 75, 17, attached by one extremity to the sides of the metacarpal bones, by the other to the contiguous extremity of the phalanges, the direction of the fibres being forwards and downwards. The *anterior* ligaments occupy the interval between these on the palmar aspect of the joints; they are thin and membranous. The synovial membrane invests the surfaces of the heads of the bones, and is reflected on the ligaments which connect them.

The phalanges are articulated with one another, 18, on the same principle as that which obtains in the articulation between their bases and the metacarpal bones; it is therefore unnecessary to repeat what has been just stated on that subject.

There are some other fibrous and ligamentous structures which deserve to be noticed in this place, but not as being connected immediately with the joints; they are rather accessories to the tendons of the muscles. Thus along the margins of the phalanges, on their palmar aspect, are attached the *vaginal ligaments*, which form sheaths for the flexor tendons, and bind them securely in their situation; these are thick and firm along the body of the phalanges, but over the flexures of the joints they are thin, so as not to impede their movements; their inner surface is lined by a fine membrane resembling the synovial class, which is reflected over the tendons, giving to each a smooth and shining appearance.

299. The *posterior annular ligament* of the wrist is continuous with the fascia of the fore-arm, of which it may be con-

sidered a part. It extends from the extremity of the radius, at its outer border, to the inner border of the ulna and the pisiform bone, and serves to bind down the extensor tendons.

300. The *anterior annular ligament* is a dense fasciculus of fibres, extended across the carpus from the pisiform and unciform bones to the trapezium and scaphoides, so as to form a canal which transmits the flexor tendons, retains them in their situation, and modifies their direction and power of action on the hand.

ARTICULATIONS OF THE PELVIS.

301. The os sacrum, considered as the common point of support of the vertebral column above, the os coccygis below, and ossa innominata on each side, is connected with each of these in the following manner:—

Sacro-vertebral articulation.—The base of the sacrum is articulated with the last lumbar vertebra by means similar to those which connect the different pairs of vertebræ throughout the column; 1, by an inter-vertebral substance placed between their oval surfaces; 2, by the continuation of the anterior and posterior common ligaments; 3, a ligamentum subflavum connecting the arches of the last vertebra with the posterior border of the sacral canal; 4, an inter-spinous ligament; 5, two synovial membranes between the articulating processes; and lastly, a sacro-vertebral ligament. All these, except the last, being similar to the connecting media throughout the column, require no farther description in this place.

The *sacro-vertebral ligament*, fig. 79, 1, extends obliquely from the transverse process of the last lumbar vertebra downwards to the depressed lateral surface at the base of the sacrum; its form is triangular, as its fibres diverge and expand towards the sacro-iliac symphysis.

The *ilio-lumbar ligament*, 2, is extended horizontally between the summit of the transverse process of the last lumbar vertebra and the posterior extremity of the crista of the ilium, where its fibres expand somewhat, so as to give it a triangular form. This is the only bond of union between the true vertebræ and the os ilium.

302. The *sacro-coccygean articulation* is effected by, 1, an *anterior ligament*, fig. 77, 3, consisting of irregular fibres, placed

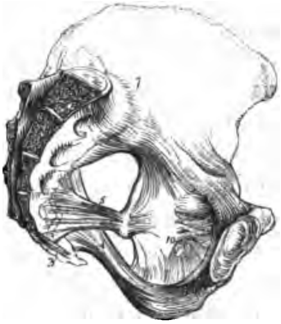
in front of these bones, subjacent to the rectum; 2, by a *posterior ligament* more strongly marked, composed of fibres which descend upon the bones of the coccyx, from the margin of the inferior orifice of the sacral canal, which it serves to close in and complete; 3, by a thin *fibro-cartilage* interposed between the contiguous extremities of the sacrum and coccyx with a synovial membrane which continues in the female to an advanced period of life.

The several pieces of the coccyx are connected one to the other by a continuation of the anterior and posterior ligaments which unite the sacrum and coccyx, and by very thin interposed fibro-cartilages. In the adult male the union between the sacrum and coccyx, and that between the pieces of the latter, are usually ossific; but in the female this change most commonly does not occur till a very advanced period of life, and the mobility increases during pregnancy.

The *sacro-iliac articulation*, often named the sacro-iliac symphysis, or synchondrosis, is formed between the rough lateral surfaces of the sacrum and ilium closely applied to one another, and connected by an irregular lamella of a cartilaginous structure. In addition to these means of union, the pelvic bones are connected by the following ligaments :—

303. The *posterior sacro-sciatic ligament*, figs. 77, 78; 4, (ligam. sacro-ischiadicum majus, Weit., Sœmm.) elongated, broad, and triangular, is placed at the inferior and posterior part of the pelvis, whose lower aperture it assists materially in closing. Its base or broader part is attached to the postero-inferior spine of the ilium and to the side of the sacrum and coccyx; whilst its other extremity is fixed along the inner margin of the tuber ischii, where it expands somewhat, and sends upwards and forwards along the margin of the ramus of that bone a falciform process, which presents one surface looking towards the perinæal space, and the other resting on the internal obturator muscle and pudic

Fig. 77.

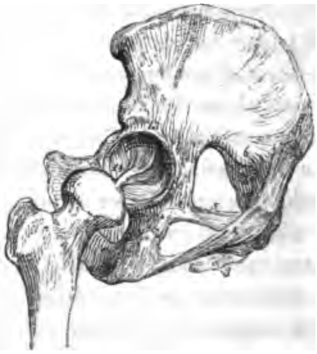


artery. The posterior surface of this ligament gives origin to part of the gluteus maximus; the anterior is covered partly by the small sacro-sciatic ligament.

304. The *anterior*, or *small sacro-sciatic ligament*, 5, (lig. sacro-ischiadicum minus, internum, Weit., Sœmm.) is attached by its base to the side of the sacrum and coccyx, where its fibres are blended with those of the great ligament, and by its apex to the spinous process of the ischium; its form is triangular, the direction of its fibres forwards and outwards. The spinous process of the ischium, its tuberosity, and these two ligaments, bound an oval interval, through which pass the obturator internus muscle, and the internal pudic vessels and nerve; but above the border of the anterior ligament is a large oval opening, (bounded before and above by the margin of the ilium and ischium, and behind by the great ligament,) which transmits the pyramidalis muscle, the great sciatic nerve, the gluteal and ischiadic vessels and nerves.

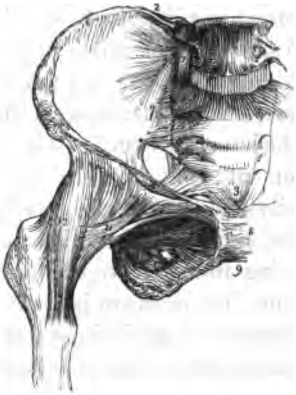
305. The *posterior sacro-iliac ligaments* consist of three or four sets of short irregular fibres, extended between the posterior rough portion of the surface on the side of the sacrum and the corresponding part of the ilium. Some of the fibres pass horizontally between the bones, others obliquely: of the latter, one band, fig. 78, 6, extending downwards from the posterior superior spine of the ilium to the tubercles on the third or fourth piece of the sacrum, is described separately, under the name of (from its direction) the *oblique*, or (from being situated superficially to the others) the *posterior sacro-iliac ligament*. They are all placed deeply in the groove formed by the ilium and sacrum, and covered by the origin of the lumbar muscles. The *anterior sacro-iliac ligament* consists of some thin irregular fibres, fig. 77, 79; 7, placed at the anterior aspect of the sacro-iliac symphysis, and attached to the pelvic surfaces of the sacrum and ilium.

Fig. 78.



306. The *pubic articulation* (symphysis pubis) is formed by the junction of the ossa pubis in the median line anteriorly. This is effected by an elongated piece of fibro-cartilage, interposed between their surfaces, and connected to each. It consists of concentric lamellæ, as indicated in fig. 77, is thicker anteriorly than posteriorly, and frequently projects beyond the level of the bones in the latter direction. A provision is made in this part for a slight degree of movement, which, however, is more perceptible in the female than in the male. Each pubic bone, properly speaking, has its own plate of fibro-cartilage. These plates are connected by fibres passing transversely from one to the other at the fore part as well as at the upper and lower border; but at the middle and back part they are smooth, and often lined by a slight synovial membrane. The union between the bones is strengthened, 1st, by an *anterior pubic ligament*, fig. 79, 8, which consists of irregular fibres, passing obliquely across from one bone to the other, and decussating on the anterior surface of the fibro-cartilage; the fibres are intermixed with those of the aponeuroses of the external oblique muscles of the abdomen; 2ndly, the *sub-pubic ligament*, fig. 79, 9, (ligamentum triangulare, arcuatum,) thick and triangular, which is placed beneath the symphysis, its sides being attached to the rami of the pubis, its base free and slightly concave, directed downwards and backwards to the perinæal space; 3rdly, by some indistinct fibres which are situated on the posterior surface of the articulation, and others placed on its upper border: these may be named from their position.

Fig. 79.



307. The *obturator ligament*, figs. 77, 79; 10, (membrana obturans foraminis thyreœidis, Sœmm.) is properly a fibrous membrane, inserted into the border of the obturator foramen, which it closes in its entire extent, except at the upper and outer part of its circumference, where a small oval aperture is

left for the exit of the obturator vessels. The obturator muscles are attached to its surfaces.

THE HIP-JOINT.

308. This is a true ball-and-socket joint, in which the globular head of the femur is received into the acetabulum or cotyloid cavity. The articulating surfaces are covered by cartilage in the greater part of their extent. It is deficient, however, at the bottom of the cavity, and also a little beneath the central point of the head of the femur; the latter marking the insertion of the round ligament, the former a shallow fossa for the lodgement of the structure which has been called the synovial gland. The connecting means in this articulation are three ligaments, viz. a capsular, cotyloid, and inter-articular ligament, together with a synovial membrane.

309. The *capsular ligament*, dense and firm in its texture, represents a fibrous tube, 11, whose direction is downwards and outwards; being attached by one extremity round the margin of the cotyloid cavity, by the other to the neck of the femur. Its superior circumference, in the greater part of its extent, is attached to the bone, within two or three lines of the cotyloid ligament; but opposite the notch, where the margin of the cavity is deficient, it is attached to the transverse ligament. Its inferior circumference is inserted in front into the oblique line leading from one trochanter to the other; but superiorly and behind, its fibres are implanted into the neck of the bone, within a quarter of an inch of the trochanteric fossa, and about the same distance from the posterior inter-trochanteric line. The ligament is most dense and firm towards the superior and anterior part of the articulation; inferiorly, its fibres are comparatively thin. A firm fasciculus, 12, of fibres extends obliquely downwards in front of the joint intimately connected with the capsule, being calculated to strengthen it, hence it is called its "accessory" ligament; but as one extremity of it is attached to the anterior inferior spinous process of the ilium, and the other to the anterior trochanteric line, it may be called the *ilio-femoral* ligament.

310. The *cotyloid ligament* is a fibro-cartilaginous ring, fig. 78, 13, placed round the cavity, and serving the purpose of

increasing its depth, and completing its border, where it is deficient. The broader part or base of this structure is attached to the bone, its thin edge is free, and both its surfaces are covered by the synovial membrane, the external being in contact with the capsular ligament, the internal with the head of the femur. Its fibres are not continued all round; they rather pass obliquely from without inwards, over the margin of the cavity, one extremity being attached to the outer, the other to its inner surface. At the cotyloid notch these fibres are continued from side to side, crossing one another, so as to render the circumference complete. Some additional fibres are superadded in this part; from which circumstance, as well as its being stretched across from one margin of the notch to the other, it is usually named the *transverse ligament.* Subjacent to the transverse portion an interval is left for the admission of the articular vessels.

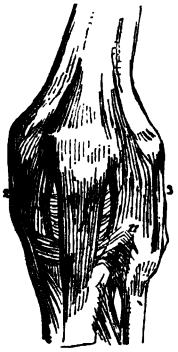
311. The *inter-articular ligament*, fig. 78, 14, is not unfrequently called the "round" ligament (ligamentum teres capitis femoris, Weit. Sœmm.) It is a thick dense fasciculus of fibres, implanted by one extremity, which is round, into the fossa in the head of the femur; by the other, where it is broad, flat, and bifid, into the margins of the cotyloid notch, where its fibres become blended with those of the transverse ligament.

312. The *synovial membrane* lines the contiguous surfaces of all the parts which enter into the composition of the articulation, giving them a smooth and shining appearance. From the margin of the articular surface of the femur, it may be traced along the neck of that bone as far as the insertion of the capsular ligament, the inner surface of which it lines as far as its superior attachment. There it turns inwards over the cotyloid ligament, and dips into the cavity, lining its entire extent, and finally guided as it were by the inter-articular ligament (which it invests by a funnel-shaped process), it reaches the head of the femur, and invests it as far as the border of its cartilage, whence we proceeded in tracing its reflections.

THE KNEE-JOINT.

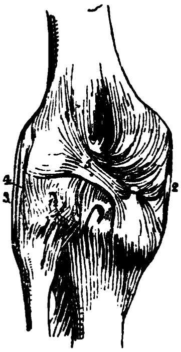
This is a ginglymus, or hinge-joint, formed by the condyles of the femur above, the head of the tibia below, and the patella in front, the contiguous surfaces of each being tipped with cartilage, and invested by a common synovial membrane. The following ligaments enter into the composition of the articulation: the ligamentum patellæ, the external and internal lateral, a posterior, a transverse, and two crucial ligaments; besides these, may be enumerated two semi-lunar fibro-cartilages, and some folds of the synovial membrane, which have received names, viz. the ligamenta alaria and mucosum; but the term ligament cannot with propriety be applied to any other than fibrous structures which connect parts together.

Fig. 80.



313. The *ligamentum patellæ*, fig. 80, 1, is a flat strong band of tendinous fibres, which connects the patella with the anterior tuberosity of the tibia. Its superior extremity is attached to the apex of the patella, and to a depression on its posterior surface; its superficial fibres pass upwards on the anterior aspect of the bone, and become continuous with those of the tendon of the rectus femoris; the inferior extremity is a little expanded; towards the middle its borders are slightly tucked in. The anterior surface of this ligament is subcutaneous in its whole extent; the posterior rests on the synovial membrane of the knee-joint, from which it is separated by some adipose substance, as it is inferiorly from the head of the tibia by a synovial bursa.

Fig. 81.



314. The *internal lateral ligament*, figs. 80, 81; 2, broad and flat, connects the tuberosity of the internal condyle of the femur with the inner surface of the head of the tibia. It becomes broad inferiorly, where it is covered by the tendons of the sartorius, gracilis, and semitendinosus muscles; internally it rests on the synovial membrane, and is attached to the internal semi-lunar cartilage.

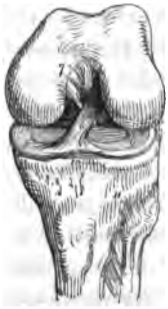
315. The *external lateral ligament*, 3, is a rounded cord-like fasciculus of fibres, which passes from the tuberosity of the external condyle of the femur, to the head of the fibula; its direction is almost vertical; it is placed nearer the posterior than the anterior surface of the joint; its internal surface corresponds with the synovial membrane and the external articular

arteries, the external being covered by the tendon of the biceps flexor cruris, and the expanded fascia of the extensor muscles. Posterior to this, but parallel with it, another ligament, fig. 81, 4, is placed, connecting the same points of the femur and fibula; it is called the *short external lateral ligament.*

316. The *posterior ligament*, fig. 81, 5, (ligamentum posticum Winslowi,) broad and expanded, is a flat plane of fibres, stretched obliquely behind the articulation, from the internal tuberosity of the tibia to the external condyle of the femur. The direction of the greater part of its fibres is from below upwards and outwards, running diagonally across the joint, being evidently continuous with the tendon of the semi-membranosus muscle, of which they may be regarded as a prolongation. This ligament, however, cannot be considered as formed solely by a reflection of the tendon of the semi-membranosus, or merely as the third insertion of that muscle; for several transverse and perpendicular fibres are observed in it, distinct from those of the reflected tendon. Some apertures may be observed between its fibres, which transmit the posterior articular vessels.

317. The *crucial* or *oblique ligaments* (ligamenta cruciata) are placed at the posterior part of the joint, external to the synovial membrane, but partially invested by it. As the name imports, their direction is oblique, so that they cross or decussate somewhat like the lines of the letter X; the posterior one, however, approaches more nearly a perpendicular direction: of these one is anterior, the other posterior. The *anterior ligament*, fig. 82, 6, is fixed by its lower extremity to a pit, situated before the spine of the tibia, where it is connected with the anterior cornu of the internal semi-lunar cartilage; its upper extremity is inserted into the inner side of the external condyle of the femur; hence its direction is upwards, backwards, and outwards. The *posterior ligament*, 7, is attached inferiorly to the pit behind the spine of the tibia (where it is intimately connected with the posterior cornu of the external semi-lunar cartilage), and superiorly, to the side of the inner condyle;

Fig. 82.



its fibres being directed upwards and a little forwards. Its interior surface is in contact with the last-mentioned ligament, and the posterior with the ligamentum posticum. Both are thus implanted into the fossa between the condyles.

318. The *semi-lunar cartilages* are two crescent-shaped lamellæ of the fibro-cartilage, placed on the articulating surfaces of the head of the tibia, interposed between them and the condyles of the femur. The outer border of each is thick and convex, the inner thin and concave, leaving the central part of the superior surface of the tibia uncovered.

The *internal semi-lunar cartilage*, fig. 82, 8, elongated from before backwards, is nearly of a semi-circular form; its anterior cornu is connected with the anterior crucial ligament, and is inserted into the pit before the spine of the tibia; the posterior is attached behind the spine, and is in relation with the posterior crucial ligament; its thick border is connected with the internal lateral ligament, the thin one is free and unattached.

The *external semi-lunar cartilage*, 9, forms nearly a complete circle; its two cornua, fixed one before, the other behind the spine of the tibia, are so close at their insertion, that they may be said to be interposed between the insertions of the internal semi-lunar cartilage. Its external border is connected behind with the tendon of the popliteus muscle, and in the middle with the external lateral ligament. Towards the front of the joint the convex borders of the inter-articular cartilages are connected by a slight transverse band, 10 (*transverse ligament*). The superior surface of the fibro-cartilages is concave, and in apposition with the condyles of the femur, the inferior plane rests on the head of the tibia; both surfaces are invested in nearly their entire extent by the synovial membrane.

319. The *synovial membrane*, like all similar structures, forms a shut sac, whose surface is continuous throughout its entire extent, and as it lines the contiguous surfaces of all the parts entering into the composition of the knee-joint, it must necessarily present rather a complex arrangement. This complexity is increased by the existence of a small funnel-shaped fold (improperly named *ligamentum mucosum*), which is stretched across the joint from the lower border of the patella to the margin of the fossa, between the condyles of the femur. In order to exhibit the arrangement of the membrane, the joint should be laid open by a vertical incision carried along the

inner margin of the patella and its ligament, leaving the ligamentum mucosum untouched. A lateral view of the joint being thus obtained, all the parts remaining in their natural position, it will be observed that the synovial sac is intersected and in a manner divided into two parts by a transverse funnel-shaped process (*ligamentum mucosum*); the superior one, elongated and pyramidal, projects by its summit more than an inch above the patella, its base corresponding with the breadth of the process just named. The inferior division of the membrane is quadrilateral, one side being made up of the lower border of the same process, and the smooth surface of the femur with which it is continuous; another by the articulating surface of the tibia; posteriorly it corresponds with the posterior crucial ligament, and anteriorly with the part of the membrane reflected on the ligamentum patellæ.

If we commence at the superior border of the patella to trace the reflections of the membrane, we find that it descends, lining its articulating surface; below its inferior border it corresponds with the ligamentum patellæ, from which it is separated by a considerable quantity of adipose matter; on reaching the margin of the tibia, it is reflected over its articulating surfaces, and also on both aspects of the semi-lunar cartilages, giving them a smooth investment; round the crucial ligaments also it forms partial investments, enclosing them as far as their attachments to the femur. The membrane will thus be found to be guided to the articulating surface of that bone at several points, viz. by the two crucial ligaments, by the funnel-shaped process, and by the external margin of the semi-lunar cartilages; from these points it expands over the condyles, and after ascending for some way in front of the femur (forming a cul-de-sac between it and the tendon of the extensor muscles), it passes downwards to the margin of the patella, from which we proceeded to trace its reflections. At the sides of the patella the membrane forms two slight folds which are named "*alar*" ligaments (ligamenta alaria).

In the enumeration of the ligaments of the knee-joint, no mention has been here made of a fibrous capsule, as an investment distinct from the other fibrous structures of the joint. It is not usually described in anatomical demonstrations, and no notice of it occurs in the works of Meckel, Portal, Cloquet, or B. Cooper. A capsular ligament is, however, attributed to this articulation by Sœmmering, Weitbrecht, and Fyfe. The capsular ligament or membrane (membrana capsularis articuli genu) is said to arise in front from the whole circumference of the articulating extremity of the femur, at some distance from its cartilaginous coating, and behind from the border of the inter-condyloid fossa, from which it descends, to be inserted into the rough border which surrounds the head of the tibia. The membrane is also inserted into the margins of the patella and its superior and inferior ligamentous connexions, so that this bone forms part of the capsule of the joint. "It is very thin, but is strengthened by the fascia of the limb, and the surrounding aponeurotic structures."

These are pretty nearly the words employed by Fyfe; the last clause approaches somewhat to a correct expression of the fact. The fascia lata is prolonged from the lower part of the thigh to the head of the tibia, and extends backwards upon the condyles, and forwards to the margins of the patella and its ligament; thus forming an exterior investment for the joint and its synovial membrane. The ligamentum posticum supplies its place at the back of the articulation.

PERONEO-TIBIAL ARTICULATION.

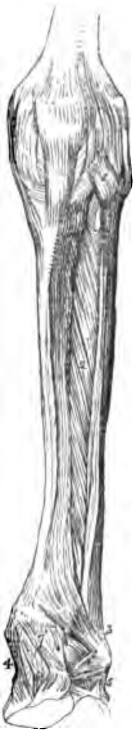
320. The superior and inferior extremities of the tibia and fibula are connected by ligaments and synovial membranes, and the shafts of these bones are moreover maintained in relation by an inter-osseous ligament.

The contiguous extremities of the bones present superiorly two flat oval surfaces covered with cartilage, which are closely applied to one another, and retained *in situ*, 1, by an *anterior ligament*, figs. 82, 11; 83, 1, which is a broad flat band of fibres, passing obliquely upwards and inwards, from the head of the fibula to the internal tuberosity of the tibia; it is covered and strengthened by the tendon of the biceps flexor cruris; 2, by a *posterior ligament*, fig. 81, 12, similarly disposed behind the articulation, but stronger and thicker; 3, by a *synovial membrane*, which lines the articulating surfaces of the bones and ligaments.

321. The *inter-osseous ligament*, fig. 83, 2, which connects the bodies of the tibia and fibula, flat and membranous, is composed of a series of parallel fibres, extending obliquely between the external ridge of the tibia, and the ridge on the adjacent surface of the fibula. Most of the fibres run outwards and downwards, others cross them, and the membrane they compose is broader above than below, and presents in the former situation

an elongated opening for the transmission of the anterior tibial vessels, and inferiorly a smaller aperture for the passage of the anterior branch of the fibular artery.

Fig. 83.



322. The inferior extremities of the tibia and fibula present two articulating surfaces, of which that of the former is concave, and receives the latter, which is convex, both being for a little way covered with cartilage; these are connected by four ligaments and a synovial membrane.

1. The *anterior ligament* (tibio-fibular), fig. 83, 3, is a flat band of fibres, extended obliquely between the heads of the bones, the direction of its fibres being downwards from the tibia to the fibula.

2. The *posterior ligament,* fig. 84, 1, somewhat triangular, is similarly disposed behind the articulation; its external surface is covered by the peronei muscles.

3. The *transverse ligament,* fig. 84, 2, longer but narrower than the former, with which its fibres are closely connected, extends from the head of the fibula to that of the tibia; it forms the posterior boundary of the ankle-joint.

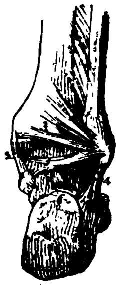
4. The *inferior inter-osseous ligament* consists of some short dense fibres, which connect the heads of the bones, as the great inter-osseous ligament does their bodies; it cannot be seen until the anterior and posterior ligaments are removed, and the bones in some degree separated.

THE ANKLE-JOINT.

323. This articulation consists of the inferior extremities of the tibia and fibula, united so as to form an arch, into which the superior convex surface of the astragalus is received. Their contiguous surfaces are covered with cartilage, lined by a synovial membrane, and retained in contact by the following ligaments. The *internal lateral ligament,* figs. 83, 4, and 84, 3, (ligamentum deltoides,) is a broad flat fasciculus of fibres, one extremity of which is attached to the inferior border of the internal malleolus, the other to the inner side of the

astragalus and os calcis. It is broader below than above; its cutaneous surface is covered by the tendon of the tibialis posticus muscle; the articular one is lined by the synovial membrane.

Fig. 84.



324. The *external lateral ligament* consists of three distinct fasciculi of fibres, separated by intervals, and disposed in different directions. 1. The central one, figs. 83, 5; 84, 4, (*ligamentum fibulæ medium,*) descends perpendicularly from the extremity of the fibula, and is inserted into the middle of the external surface of the os calcis. 2. The anterior fasciculus, fig. 83, 6 (*ligamentum fibulæ anterius*), passes obliquely forwards from the inferior extremity of the fibula, to the anterior border of the articular surface of the astragalus; it is the shortest of the three. 3. The posterior, fig. 84, 5, (*ligamentum fibulæ posterius,*) the strongest of the three ligaments, passes obliquely backwards from the extremity of the fibula, towards the posterior surface of the astragalus, where it is inserted into the border of the groove for the tendon of the flexor longus pollicis.

325. At the anterior aspect of the joint is a broad thin membranous band, fig. 83, 7, composed of irregular fibres, extended obliquely from the border of the articulating surface of the tibia to the margin of the pulley-like surface of the astragalus. This is usually called the *tibio-tarsal ligament;* it is covered by the tendons of the extensor muscles.

326. The *synovial membrane*, after having invested the articulating surface of the astragalus, is reflected upwards at each side upon the lateral ligaments, and at the anterior and posterior part of the joint, upon the corresponding fibrous structures, so as to reach the articulating surfaces of the tibia and fibula by several points at once. These it lines in their entire extent, and also sends upwards between the bones a process which reaches as far as the inferior inter-osseous ligament; so that the inferior articulation between these bones may be said to form part of the ankle-joint, as both are lined by the same synovial membrane.

ARTICULATIONS OF THE FOOT.

327. The foot is constructed on the principle of an arch, being concave inferiorly, where it rests on the ground, and convex superiorly, where it receives the weight of the body, transmitted to it by the bones of the leg. The posterior extremity, or heel, is narrow, thick, and rounded; the anterior, flat, thin, and expanded, being composed of the digital phalanges. The internal border, longer than the external, thick, and nearly straight, is composed of the inner border of the calcaneum, the scaphoid, first cuneiform, and first metatarsal and digital bones of the great toe : the external, shorter and thinner, consists of the calcaneum, the cuboid, the fifth metatarsal, and corresponding digital bones.

The foot being divided into the tarsus, metatarsus, and phalanges, its different parts are respectively bound together by ligaments, and all are united so as to form a whole.

The seven bones of which the tarsus consists may be divided into two sets, the os calcis and astragalus forming the first, the scaphoid, cuboid, and three cuneiform bones, the second.

Articulation of the astragalus with the calcaneum.

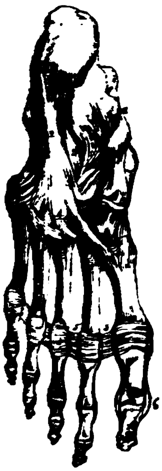
328. The astragalus is connected to the calcaneum by three ligaments, the chief of which is situated between the bones, and unites them somewhat after the manner that bivalve shells are connected by their muscle. This is termed the *inter-osseous ligament;* its breadth from side to side is more than an inch; the fibres of which it is composed pass perpendicularly between the bones, one extremity being fixed to the groove between the articulating surfaces of the calcaneum, the other to a corresponding depression in the astragalus. The *posterior ligament,* fig. 84, 6, connects the posterior border of the astragalus with the upper surface of the calcaneum; its fibres are oblique, its length and breadth not more than three or four lines. The *external ligament* is a slight fasciculus which descends perpendicularly from the under surface of the astragalus to the external side of the calcaneum; its direction is parallel with the external lateral ligament of the ankle-joint. It may be farther observed, that as the astragalus is wedged in between the malleoli, and as the

lateral ligaments pass downwards from these to the os calcis, they must contribute somewhat to retain the astragalus in its proper position with regard to the latter bone.

Articulation of the calcaneum with the scaphoid bone.

329. This is effected by means of two ligaments, their surfaces not being in contact. Of these ligaments, the inferior, or plantar one, fig. 85, 1, (*ligamentum calcaneo-scaphoideum inferius*, Meckel,) much the largest, passes forwards and inwards from the extremity of the calcaneum to the inferior surface of the scaphoid bone; its fibres are flat and horizontal, and in contact inferiorly with the tendon of the tibialis posticus muscle; superiorly they form part of the *fossa* which receives the head of the astragalus. The *external* or *dorsal ligament* (lig. calcaneo-scaphoideum externum) forms the external boundary of the cavity just mentioned; its fibres, very short, are directed from behind forwards between the contiguous extremities of the bones.

Fig. 85.



Articulation of the astragalus with the scaphoid bone.

330. The astragalus forms with the scaphoid bone a ball-and-socket joint. The anterior articulating surface of the calcaneum, and the inferior calcaneo-scaphoid ligament, also may be said to enter into this articulation, as all the parts here mentioned are lined by a common synovial membrane. On the dorsum of the foot the astragalus is retained in its situation by the *ligamentum astragalo-scaphoideum*, a broad band of fibres extending obliquely forwards from the anterior extremity of the astragalus to the superior surface of the scaphoid bone. It is covered by the extensor tendons. The necessity for an inferior ligament between these bones is removed by the existence of the calcaneo-scaphoid ligament. The *synovial membrane* lines the concave surface of the scaphoid bone, the calcaneo-scaphoid ligament, and the elongated articulating surface of the calcaneum; from these it is reflected to the under surface of the astragalus and its

scaphoid ligament, and so to the bone of that name from which we began to trace it.

Articulation of the calcaneum with the cuboid bone.

331. The connexion between these bones is maintained by three ligaments and a synovial membrane. The *superior calcaneo-cuboid ligament* is a broad flat band of fibres, which connects the anterior and superior surface of the calcaneum with the adjacent part of the cuboid bone. The *inferior* ligament consists of two distinct fasciculi of fibres, differing in form and attachments, of which one is superficial, the other deep-seated. The superficial one, called the *long plantar ligament*, fig. 85, 2, (ligamentum longum plantæ,) is the longest of the tarsal ligaments. Its fibres, attached posteriorly to the inferior surface of the calcaneum, pass horizontally forwards, and become intimately connected with the rough tuberosity on the under surface of the cuboid bone; the greater number of them are continued forwards, and terminate at the base of the third and fourth metatarsal bones. The *deep-seated calcaneo-cuboid ligament*, 3, lies close to the bones, being separated from the former by some cellular tissue; its breadth is considerable, its length scarcely an inch, one extremity being attached to the calcaneum before the long ligament, the other (somewhat expanded) to the under surface of the cuboid bone. A synovial membrane lines the contiguous surfaces of the two bones, and is necessarily reflected upon the articular aspects of the superior calcaneo-cuboid ligament and the deep-seated ligament just noticed.

Articulations between the second set or range of tarsal bones.

332. The second range of the tarsal bones, viz. the scaphoid, cuboid, and three cuneiform, are connected together in the following manner, so as to form separate articulations between each pair of them.

1. The *scaphoid* and *cuboid* bones, when in contact, which is not always the case, present two small articulating surfaces, at their edges covered with cartilage, and lined by a synovial membrane. They are connected by a *dorsal ligament*, composed of short thin fibres, extended obliquely between the two bones; and *a plantar*, situated in the sole of the foot, and composed of transverse fibres.

2. The *cuboid* and *the external cuneiform bones* are connected by a *dorsal* ligament, which is a thin fasciculus of fibres extended between them, and a *plantar ligament*, whose fibres are transverse.

3. The *scaphoid* and *the cuneiform bones* are held together by dorsal and plantar ligaments. It will be recollected that the scaphoid bone articulates with the three cuneiform, by the smooth faces on its anterior surface. The *dorsal* ligaments, three in number, pass from the superior surface of the scaphoid to the first, second, and third cuneiform bones, into which they are inserted. The *plantar ligaments* are similarly disposed on the under surface of the bones, but not so strongly marked.

4. The three *cuneiform* bones are connected by two dorsal and two plantar ligaments extended transversely from side to side; the internal one is broader and stronger than the other. The contiguous flat surfaces of the bones are lined by synovial membranes.

Articulation of the tarsus and meta-tarsus.

333. The four anterior bones of the tarsus, viz. the three cuneiform and the cuboid, articulate with the meta-tarsus. The first and third cuneiform bones project beyond the others; so that the anterior extremity of the tarsus is very irregular. The first meta-tarsal bone articulates with the internal cuneiform; the second is wedged in between the first and third cuneiform; the third meta-tarsal bone articulates with the extremity of the corresponding cuneiform, and the two last with the cuboid bone. The articular surfaces of the bones are lined by synovial membranes, and they are held in contact by *dorsal* and *plantar* ligaments. These are flat, thin bands of parallel fibres, which pass from behind forwards, connecting the contiguous extremities of the bones just mentioned. Thus the first meta-tarsal bone receives a broad thin band from the corresponding cuneiform bone; the second receives three, which converge to its upper surface, one passing from each cuneiform bone; the third has one from the third bone of that name: and, finally, the two last are bound by a broad fasciculus to the cuboid bone. The plantar set is similarly disposed; the first and second are more strongly marked than the corresponding ligaments on the dorsal surface.

Articulations of the meta-tarsal bones with one another.

334. The five elongated bones which form the meta-tarsus are connected by ligaments, so as to form an integrant part of the foot. At their posterior or tarsal extremity, two sets of ligaments are situated, one on the dorsal, the other on the plantar surface. These consist of three short thin bands of fibres, which pass transversely across the contiguous extremities of the four last meta-tarsal bones; the plantar set, fig. 85, 4, is similarly disposed; but no such connexion exists between the first and second bones. At the anterior, or digital extremity, the five bones are connected by a *transverse* ligament, 5, 5, which is a flat thin band of fibres, passing across from the extremity of one bone to the other; it is situated on the plantar surface of the meta-tarsus.

Articulations of the meta-tarsal bones with the digital phalanges.

335. The anterior extremities of the meta-tarsal bones are connected with those of the phalanges by two lateral ligaments, an inferior ligament, and a synovial membrane, similar in every respect to those of the hand.

The articulations of the phalanges with one another are also constructed on the same principle as those of the superior extremity. In each, the bones are held in contact by two lateral ligaments, fig. 85, 6, and an anterior ligament which is thin and membranous; the surfaces being lined by a synovial membrane.

CHAPTER IV.

OF THE MUSCLES.

336. The muscles are divisible into a number of groups, which occupy different regions of the body, and combine in various ways for the performance of its actions. We shall in the first place name the individual muscles included in each group, then indicate the method of dissecting or exposing them to view; the detailed description of each shall follow, and the rationale of their actions conclude the section.

EPICRANIAL REGION.

337. On the roof of the skull we find but one muscle, viz. the occipito-frontalis.

Dissection.—Care must be taken in making the first incisions to expose this muscle, particularly along the vertex; for the peri-cranium or tegument is very thick, and at the same time firmly adherent to the thin aponeurosis of the muscle, which is by almost every beginner detached with the tegument: this is the more likely to happen, as the aponeurosis is lifted up from the bone in the effort made to render the tegument tense. The better plan, therefore, is, to commence the dissection in such a way as to expose the fleshy fibres of the muscle; and then, taking these as a guide, to elevate the tegument from before

NOTE.—When proceeding with the dissection of a body, the examination of its upper and lower half is, for obvious reasons, carried on at the same time by different persons. Begin the dissection of the upper half with the epicranial region, (sect. 337,) then take the auricular; observe the temporal fascia and muscle; then, without delay, open the skull, as the brain speedily decomposes, and proceed with the examination of its membranes, vessels, and internal structure (*see* Brain, dissection of). When this is concluded, let the dissection of the different groups of muscles in the face, orbit, and neck, be continued in the order here set down. Do not pass over or neglect the brief directions given for the examination of each region.

Those to whom the lower half of the body is allotted should commence with the abdominal muscles. These are confessedly of great importance; but still no time should be lost in inspecting them, as it is necessary, as soon as it can be effected, to proceed to the abdominal viscera. The perinæal muscles should in the next place engage attention, as they too become, in a short time, pale and

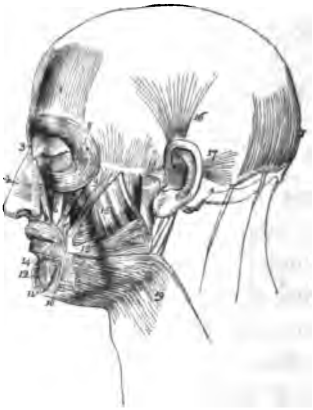
and from behind upwards to the vertex from off the aponeurosis. Place a high block under the back of the neck so as to raise the head nearly into the vertical position,—or, if the subject be turned prone, place the block under the chin. Make an incision across the forehead, about an inch above the upper margin of the orbit, and extending from the middle line outwards to the temple. Then a second incision may be carried from the inner termination of the one just indicated, upwards, over the middle of the forehead to the vertex; raise the skin at the angle formed by the junction of these incisions, and cautiously dissect it upwards and outwards, which will expose the fleshy fibres of the frontal part of the muscle. Having proceeded so far at the fore-part, make a transverse incision from the occipital protuberance to the root of the mastoid process, a little above, but parallel with the superior curved line of the occipital bone. Another incision may be drawn at right angles with this from the occipital protuberance upwards to the vertex; and from the angle of union of these incisions begin and continue the dissection, raising the skin from the occipital part of the muscle, and so proceeding from the fleshy fibres upwards to the crown of the head. In conducting this dissection, the superficial filaments of the supra-orbital nerves will be seen in front, the temporal branches of the portio dura at the sides, and the ascending branches of the posterior divisions of the cervical nerves behind; also the branches of the temporal and occipital arteries. When it is not deemed necessary to retain the large flap of tegument thus dissected off, and reflected down over the ear and side of the neck, it can be readily detached by an incision carried from the outer angle of the orbit backwards to the mastoid process.

flaccid. Then take the muscles of the lower extremity in the order in which they are here placed.

If a student in his first essay at dissection has proceeded in this way, I would suggest to him to begin the second (its upper half) with the muscles of the back, which are usually left untouched till they are unfit for any purpose. As to the lower half, let that commence, for the like reason, with the gluteal and posterior femoral regions.

The remarks on the actions of muscles had better be passed over by junior students, until they become accurately acquainted with their points of attachment,—their form, and their lines of direction with regard to the axes of the bones. A perusal of them will then serve the purpose of a repetition, and suggest a strong motive to make another and a more careful dissection than could be expected in a first attempt. In doing this it will not suffice merely to trace the outline of each muscle; its points of attachment should be exactly defined by carefully removing the cellular tissue and every extraneous substance which obscures them. (See the Table of Muscles, in the order of Dissection, at the end of this chapter.)

Fig. 86.



338. *m. Occipito-frontalis* (epi-cranius) is a flat, thin digastric muscle, fig. 86, 1, 1, extended from the occiput to the forehead (from which circumstance its name is derived), and placed immediately beneath the cranial integument, to which it closely adheres, at the same time that it rests upon the arch of the skull over which it slides. It consists of two broad but short fleshy bellies, united by an intervening aponeurosis. The posterior fleshy portion is attached to the external two-thirds of the superior curved line of the occipital bone, and to the mastoid portion of the temporal bone. The fleshy fibres, which are about an inch and a half in length, proceed forwards and upwards, and soon terminate by becoming continuous with the aponeurosis. The aponeurosis consists, for the most part, of longitudinal fibres, which form a plane corresponding with the roof of the skull, over which it slides, and ends by giving attachment to the anterior fleshy part of the muscle. The fleshy fibres, of which the frontal portion is composed, extend downwards and forwards on the frontal bone; they are longer than those of the occipital part; their upper margin, being their junction with the aponeurosis, presents a curved line, which is a little below the coronal suture; the inner fibres, corresponding with the median line, descend vertically, and become continuous with the pyramidalis nasi, 3; the middle fibres, longer than the others, terminate by becoming blended with the orbicularis, 2, and corrugator supercilii; and the external fibres curve inwards somewhat, and become blended with those of the orbicularis palpebrarum over the external angular process. The posterior attachment of the muscle lies immediately above the attachment of the trapezius, splenius capitis, and sterno-mastoid, to the superior curved line of the occipital bone; the anterior corresponds with the superior margin of the orbit. The external border of the aponeurosis

presents an arched margin, which overlaps that of the temporal muscle; but over the roof of the skull, the aponeurotic expansions from the two muscles of opposite sides are united, so as to form a continuous lamella.

Some anatomists consider this to be a four-headed muscle, having two fleshy portions behind, one on each side of the median line, and two similarly disposed in front, all connected by a single layer of aponeurosis, which rests on the cranium, and is therefrom named *galea* capitis. Others view it in a different way, the fleshy parts being taken as separate muscles, and named from their position, the anterior one being the "frontal" muscle, the posterior the "occipital." At an early period of the developement there is a digastric muscle at each side of the median line, composed of a fleshy part before and behind, joined by an intervening aponeurosis, and so we have here described it. But when the union along the vertex is completed, the aponeuroses become joined, no trace of their original separation remaining.

Actions.—These two muscles having one broad common aponeurosis, act together: their first effect is to draw up the eye-brows, the next to throw the skin of the forehead into transverse folds or wrinkles. Some persons possess the power of moving the hairy scalp backwards and forwards, by bringing the occipital and frontal parts of the muscle alternately into action.

MUSCLES OF THE FACE.

339. The muscles of the face are easily and conveniently arranged in groups, each occupying what may be called a region. The circumference of the orbit with the eye-brow and eye-lids forms the palpebral region; the side of the nose—the nasal; the cheek, or side-face—the superior maxillary; the circumference of the mouth, and the space between the jaws—the intermaxillary; that corresponding with the lower jaw—inferior maxillary. The interior of the orbit forms a separate region—the orbital; so does the space round the ear—the auricular; that of the temple and side of the jaw, the temporo-maxillary; finally, the region of the pterygo-maxillary fossa. To expose the muscles of the front and side of the face, proceed as follows:—

The *dissection of the face* may be commenced by making an incision from the vertex along the middle line of the forehead and nose, taking care that it barely divides the skin. From this, two lines may be drawn outwards, one over the eye-brow to the side of the head, the other over the zygoma to the ear. The interval intercepted between these two parallel lines may be intersected, midway between the ear and orbit, by a perpendicular line drawn from one to the other. A square (*palpebral region*) is thus marked out over the orbicularis muscle, the skin of which should be carefully reflected from its borders and angles. The dissection is continued from its outer and upper border or circumference, the point of the scalpel being made to trace the course of the curved fibres of the muscle as far as the margin of the eye-lids. The external flap may then be reflected back over the ear, so as to expose the temporal fascia, artery, &c. The skin, in the next place, is to be carefully raised and dissected off the frontal muscle, from below upwards over the forehead as far as the vertex.

The fibres of the orbicularis, after being carefully examined, particularly at the inner border of the orbit, may now be divided along the eye-brow, so as to expose the corrugator supercilii; and if the lower border of the orbicularis be raised, it will expose the origin of the elevator of the lip, which will afford a guide to the dissection of that muscle, as well as of the common elevator of the lip and nose, down to their termination (*nasal region*). The transversalis nasi is partly concealed by the latter, but it emerges from under its inner border as it advances upon the side of the nose.

In order to expose the muscles and vessels of the lower part of the face, an incision may be made from the most prominent point of the cheek downwards to the margin of the jaw, from which the skin may be reflected backwards off the masseter muscle and parotid gland, taking care not to injure the duct of the latter, or the nerves and artery which accompany it; but the other flap of skin is to be carried obliquely inwards to the lip, in the direction of the zygomaticus. By this measure, the last-named muscle, and the levator anguli oris, and also the facial artery, will be exposed; and, by removing some adipose substance, the buccinator will be brought into view (*inter-maxillary region*). By turning aside the elevator of the lip, the second branch of the fifth nerve and the infra-orbital artery will be seen emerging from the foramen of that name.

PALPEBRAL REGION.

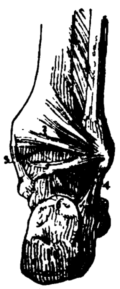
340. We have here four muscles, which act on the eye-lids, two being placed outside the orbit; viz. orbicularis palpebrarum

and corrugator supercilii; and two within it, viz. levator palpebræ and tensor tarsi.

341. *m. Orbicularis palpebrarum*, fig. 86, 2, (naso-palpebralis,) is situated at the base of the orbit, forming a thin flat plane of elliptic fibres, which is placed immediately under the skin of the eye-lids, resting on the eye-brow above, and spreading outwards somewhat on the temple, and downwards on the cheek. It is superficial in its entire extent, and closely adherent to the skin. The only points of fixed attachment (to bone) which its fleshy fibres possess are at the inner margin of the orbit; they are free in the rest of their extent, except along the eye-brow, where they are blended with the occipito-frontalis and corrugator supercilii. The fibres of the muscle form an ellipsis, whose great axis extends horizontally across the orbit from its inner angle to the temple, and corresponds with the fissure between the eye-lids. At the inner commissure of the eye-lids is a small tendon (*tendo palpebrarum*), which is often obscured by the fibres of the muscle, but is rendered apparent by drawing the lids outwards: this tendon is about two lines in length, and one in breadth; it is attached to the anterior margin of the lachrymal groove, from which it runs horizontally outwards to the inner commissure of the eye-lids, where it divides into two thin fibrous lamellæ, which diverge as they pass outwards in the substance of the eye-lids, and terminate in the tarsal cartilages. One surface of the tendon is subcutaneous, the other crosses the lachrymal sac a little above its centre, and from it a thin but firm fascia is given off, which spreads over the lachrymal sac, and adheres to the margins of the groove which lodges it. The muscular fibres are attached, 1st, to the upper margin and antesurface of the tendon just described; 2nd, to the surface of the nasal process of the superior maxilla, near the anterior margin of the lachrymal groove; 3rd, to the nasal process of the frontal bone. The fibres of the orbicularis muscle thus arising arch upwards and outwards in the direction of the eye-brow and upper lid, and thence descend over the external angle of the orbit, returning to the points above stated. The external or orbital part of the muscle consists of distinct and well-marked fibres, whilst those of the tarsal or inner part are pale and thin; but all describe concentric curves, the centre of which bounds the aperture of the eye-lids. The anterior surface of the muscle

astragalus and os calcis. It is broader below than above; its cutaneous surface is covered by the tendon of the tibialis posticus muscle; the articular one is lined by the synovial membrane.

Fig. 84.



324. The *external lateral ligament* consists of three distinct fasciculi of fibres, separated by intervals, and disposed in different directions. 1. The central one, figs. 83, 5; 84, 4, (*ligamentum fibulæ medium,*) descends perpendicularly from the extremity of the fibula, and is inserted into the middle of the external surface of the os calcis. 2. The anterior fasciculus, fig. 83, 6 (*ligamentum fibulæ anterius*), passes obliquely forwards from the inferior extremity of the fibula, to the anterior border of the articular surface of the astragalus; it is the shortest of the three. 3. The posterior, fig. 84, 5, (*ligamentum fibulæ posterius,*) the strongest of the three ligaments, passes obliquely backwards from the extremity of the fibula, towards the posterior surface of the astragalus, where it is inserted into the border of the groove for the tendon of the flexor longus pollicis.

325. At the anterior aspect of the joint is a broad thin membranous band, fig. 83, 7, composed of irregular fibres, extended obliquely from the border of the articulating surface of the tibia to the margin of the pulley-like surface of the astragalus. This is usually called the *tibio-tarsal ligament;* it is covered by the tendons of the extensor muscles.

326. The *synovial membrane*, after having invested the articulating surface of the astragalus, is reflected upwards at each side upon the lateral ligaments, and at the anterior and posterior part of the joint, upon the corresponding fibrous structures, so as to reach the articulating surfaces of the tibia and fibula by several points at once. These it lines in their entire extent, and also sends upwards between the bones a process which reaches as far as the inferior inter-osseous ligament; so that the inferior articulation between these bones may be said to form part of the ankle-joint, as both are lined by the same synovial membrane.

ARTICULATIONS OF THE FOOT.

327. The foot is constructed on the principle of an arch, being concave inferiorly, where it rests on the ground, and convex superiorly, where it receives the weight of the body, transmitted to it by the bones of the leg. The posterior extremity, or heel, is narrow, thick, and rounded; the anterior, flat, thin, and expanded, being composed of the digital phalanges. The internal border, longer than the external, thick, and nearly straight, is composed of the inner border of the calcaneum, the scaphoid, first cuneiform, and first metatarsal and digital bones of the great toe : the external, shorter and thinner, consists of the calcaneum, the cuboid, the fifth metatarsal, and corresponding digital bones.

The foot being divided into the tarsus, metatarsus, and phalanges, its different parts are respectively bound together by ligaments, and all are united so as to form a whole.

The seven bones of which the tarsus consists may be divided into two sets, the os calcis and astragalus forming the first, the scaphoid, cuboid, and three cuneiform bones, the second.

Articulation of the astragalus with the calcaneum.

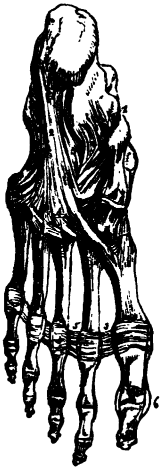
328. The astragalus is connected to the calcaneum by three ligaments, the chief of which is situated between the bones, and unites them somewhat after the manner that bivalve shells are connected by their muscle. This is termed the ***inter-osseous ligament;*** its breadth from side to side is more than an inch; the fibres of which it is composed pass perpendicularly between the bones, one extremity being fixed to the groove between the articulating surfaces of the calcaneum, the other to a corresponding depression in the astragalus. The ***posterior ligament,*** fig. 84, 6, connects the posterior border of the astragalus with the upper surface of the calcaneum; its fibres are oblique, its length and breadth not more than three or four lines. The ***external ligament*** is a slight fasciculus which descends perpendicularly from the under surface of the astragalus to the external side of the calcaneum; its direction is parallel with the external lateral ligament of the ankle-joint. It may be farther observed, that as the astragalus is wedged in between the malleoli, and as the

lateral ligaments pass downwards from these to the os calcis, they must contribute somewhat to retain the astragalus in its proper position with regard to the latter bone.

Articulation of the calcaneum with the scaphoid bone.

329. This is effected by means of two ligaments, their surfaces not being in contact. Of these ligaments, the inferior, or plantar one, fig. 85, 1, (*ligamentum calcaneo-scaphoideum inferius*, Meckel,) much the largest, passes forwards and inwards from the extremity of the calcaneum to the inferior surface of the scaphoid bone; its fibres are flat and horizontal, and in contact inferiorly with the tendon of the tibialis posticus muscle; superiorly they form part of the fossa which receives the head of the astragalus. The *external* or *dorsal ligament* (lig. calcaneo-scaphoideum externum) forms the external boundary of the cavity just mentioned; its fibres, very short, are directed from behind forwards between the contiguous extremities of the bones.

Fig. 85,



Articulation of the astragalus with the scaphoid bone.

330. The astragalus forms with the scaphoid bone a ball-and-socket joint. The anterior articulating surface of the calcaneum, and the inferior calcaneo-scaphoid ligament, also may be said to enter into this articulation, as all the parts here mentioned are lined by a common synovial membrane. On the dorsum of the foot the astragalus is retained in its situation by the *ligamentum astragalo-scaphoideum*, a broad band of fibres extending obliquely forwards from the anterior extremity of the astragalus to the superior surface of the scaphoid bone. It is covered by the extensor tendons. The necessity for an inferior ligament between these bones is removed by the existence of the calcaneo-scaphoid ligament. The *synovial membrane* lines the concave surface of the scaphoid bone, the calcaneo-scaphoid ligament, and the elongated articulating surface of the calcaneum; from these it is reflected to the under surface of the astragalus and its

scaphoid ligament, and so to the bone of that name from which we began to trace it.

Articulation of the calcaneum with the cuboid bone.

331. The connexion between these bones is maintained by three ligaments and a synovial membrane. The *superior calcaneo-cuboid ligament* is a broad flat band of fibres, which connects the anterior and superior surface of the calcaneum with the adjacent part of the cuboid bone. The *inferior* ligament consists of two distinct fasciculi of fibres, differing in form and attachments, of which one is superficial, the other deep-seated. The superficial one, called the *long plantar ligament*, fig. 85, 2, (ligamentum longum plantæ,) is the longest of the tarsal ligaments. Its fibres, attached posteriorly to the inferior surface of the calcaneum, pass horizontally forwards, and become intimately connected with the rough tuberosity on the under surface of the cuboid bone ; the greater number of them are continued forwards, and terminate at the base of the third and fourth metatarsal bones. The *deep-seated calcaneo-cuboid ligament*, 3, lies close to the bones, being separated from the former by some cellular tissue ; its breadth is considerable, its length scarcely an inch, one extremity being attached to the calcaneum before the long ligament, the other (somewhat expanded) to the under surface of the cuboid bone. A synovial membrane lines the contiguous surfaces of the two bones, and is necessarily reflected upon the articular aspects of the superior calcaneo-cuboid ligament and the deep-seated ligament just noticed.

Articulations between the second set or range of tarsal bones.

332. The second range of the tarsal bones, viz. the scaphoid, cuboid, and three cuneiform, are connected together in the following manner, so as to form separate articulations between each pair of them.

1. The *scaphoid* and *cuboid* bones, when in contact, which is not always the case, present two small articulating surfaces, at their edges covered with cartilage, and lined by a synovial membrane. They are connected by a *dorsal ligament*, composed of short thin fibres, extended obliquely between the two bones ; and *a plantar*, situated in the sole of the foot, and composed of transverse fibres.

2. The *cuboid* and *the external cuneiform bones* are connected by a *dorsal* ligament, which is a thin fasciculus of fibres extended between them, and a *plantar ligament*, whose fibres are transverse.

3. The *scaphoid* and *the cuneiform bones* are held together by dorsal and plantar ligaments. It will be recollected that the scaphoid bone articulates with the three cuneiform, by the smooth faces on its anterior surface. The *dorsal* ligaments, three in number, pass from the superior surface of the scaphoid to the first, second, and third cuneiform bones, into which they are inserted. The *plantar ligaments* are similarly disposed on the under surface of the bones, but not so strongly marked.

4. The three *cuneiform* bones are connected by two dorsal and two plantar ligaments extended transversely from side to side; the internal one is broader and stronger than the other. The contiguous flat surfaces of the bones are lined by synovial membranes.

Articulation of the tarsus and meta-tarsus.

333. The four anterior bones of the tarsus, viz. the three cuneiform and the cuboid, articulate with the meta-tarsus. The first and third cuneiform bones project beyond the others; so that the anterior extremity of the tarsus is very irregular. The first meta-tarsal bone articulates with the internal cuneiform; the second is wedged in between the first and third cuneiform; the third meta-tarsal bone articulates with the extremity of the corresponding cuneiform, and the two last with the cuboid bone. The articular surfaces of the bones are lined by synovial membranes, and they are held in contact by *dorsal* and *plantar* ligaments. These are flat, thin bands of parallel fibres, which pass from behind forwards, connecting the contiguous extremities of the bones just mentioned. Thus the first meta-tarsal bone receives a broad thin band from the corresponding cuneiform bone; the second receives three, which converge to its upper surface, one passing from each cuneiform bone; the third has one from the third bone of that name: and, finally, the two last are bound by a broad fasciculus to the cuboid bone. The plantar set is similarly disposed; the first and second are more strongly marked than the corresponding ligaments on the dorsal surface.

Articulations of the meta-tarsal bones with one another.

334. The five elongated bones which form the meta-tarsus are connected by ligaments, so as to form an integrant part of the foot. At their posterior or tarsal extremity, two sets of ligaments are situated, one on the dorsal, the other on the plantar surface. These consist of three short thin bands of fibres, which pass transversely across the contiguous extremities of the four last meta-tarsal bones; the plantar set, fig. 85, 4, is similarly disposed; but no such connexion exists between the first and second bones. At the anterior, or digital extremity, the five bones are connected by a *transverse* ligament, 5, 5, which is a flat thin band of fibres, passing across from the extremity of one bone to the other; it is situated on the plantar surface of the meta-tarsus.

Articulations of the meta-tarsal bones with the digital phalanges.

335. The anterior extremities of the meta-tarsal bones are connected with those of the phalanges by two lateral ligaments, an inferior ligament, and a synovial membrane, similar in every respect to those of the hand.

The articulations of the phalanges with one another are also constructed on the same principle as those of the superior extremity. In each, the bones are held in contact by two lateral ligaments, fig. 85, 6, and an anterior ligament which is thin and membranous; the surfaces being lined by a synovial membrane.

elliptic in its form, and composed of concentric fibres so placed as to surround the aperture of the mouth. It is flat and thin; its inner surface being in contact with the mucous membrane, the external with the skin and the fibres of the different muscles which converge towards the margin of the mouth. The longer axis of the ellipse is transverse, so as to correspond with the fissure between the lips; the curves described by the fibres of the upper segment look downwards, and those of the lower one upwards; hence they are often found to decussate at the angles of the mouth. One border of each segment is free, and corresponds with the red part of the lip; the other is blended with the several muscles which converge to the mouth from different parts of the face.

Actions.—The aperture of the mouth is susceptible of considerable dilatation and contraction, the former being effected by the different muscles which converge to it, and which may be compared to retractors drawing with different degrees of obliquity the lips, or their angles, in the direction of their respective points of attachment. The elevators are necessarily placed at the upper part of the face, the depressors in the opposite situation, and the proper retractors on each side, and these are the zygomatici and the buccinators. The buccinators also contract and compress the cheeks; this power is brought into play when any substance becomes lodged in the interval between them and the jaws. The fibres of the muscles are then elongated and pressed outwards; but when they begin to act, they form a flat plane, which is pressed inwards, and so forces the substance back into the cavity of the mouth. It is obvious that the orbicular muscle must be the direct antagonist of all those that converge to it. When describing the muscles, we may commence at the lips as a common point of departure, and trace their fibres from thence as they diverge, radiating to their respective attachments.

TEMPORO-MAXILLARY REGION.

358. This space, extending from the side of the head to the angle of the jaw, contains the temporal and masseter muscles.

Dissection.—To expose the masseter muscle, and with it the duct and the surface of the parotid gland, it will suffice to reflect back the skin from the lines of incision indicated in the previous dissections. In doing this, a large branch of the facial nerve will be found accompanying the parotid duct. This will serve as a clue to the trunk of that nerve, by following it back through the substance of the parotid gland; and when the trunk is found, there can be no difficulty in pursuing all its branches, as they diverge from that point in three different directions over the face and side of the head. The superficial temporal vessels are at the same time brought into view. Cut the duct across, raise it and the accompanying piece of the parotid gland together, and draw it out towards the ear. This will expose the anterior margin of the gland and its relations to the ramus of the jaw. A little more dissection is required to get a view of its posterior border, and of its relations to the parts deeply seated between the jaw and the ear.

The next thing to be done is to get at the insertion of the temporal muscle, and at the same time bring into view the pterygo-maxillary region: proceed as follows:—

The masseter muscle and parotid gland having been examined, the parts concealed inside the ramus of the jaw may be brought into view in the following way:—With a sharp chisel and mallet the zygoma may be divided at both extremities, and the attachment of the temporal fascia to its upper border severed. The bony arch, with the masseter still connected with it, may be drawn down to the angle of the jaw, the fibres of the latter being at the same time detached from the ramus. In the next place, with Hey's saw, the ramus of the jaw may be divided by a perpendicular cut, carried from just before its condyle to a level with the alveolar border, and there met by another line carried forwards to the latter, so as to insulate and detach all that part of it which belongs to the coronoid process. This being done, the piece of bone, with the temporal muscle attached, may be drawn upwards, so as fully to expose the two pterygoid muscles *(pterygo-maxillary region)*, the internal maxillary artery, the gustatory and dental nerves, and the pterygo-maxillary ligament, which gives attachment to the buccinator and superior constrictor muscles.

359. *m. Masseter*, fig. 86, 15, (zygomato-maxillaris,) is extended from the malar bone and the zygoma to the angle of the lower jaw. Its form is that of an oblong square; its direction downwards and a little backwards. It is a thick, compressed mass of fleshy and tendinous fibres, arranged so as to form two bundles, differing in size and direction. The *external*, or larger portion of the muscle, arises from the lower border of the malar bone, and somewhat from the malar tuberosity of the superior

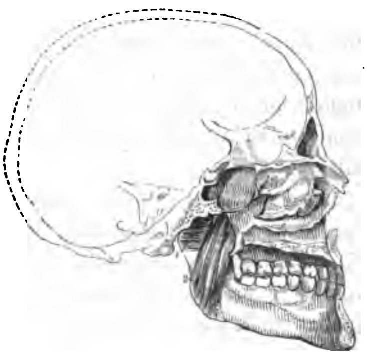
maxilla, from which its fibres proceed downwards, and a little backwards, to be inserted into the lower half of the ramus of the jaw, extending as far as its angle. The *internal*, or smaller part, consists of fibres, whose direction is for the most part vertical, some inclining a little forwards. It arises by fleshy and tendinous fibres from the lower border of the zygomatic process of the temporal bone (extending as far back as its tubercle), and is inserted into the upper half of the ramus of the jaw. This part of the muscle is concealed, in the greater part of its extent, by the larger portion, with which its fibres become united at their insertion; part, however, projects behind it, and is covered by the parotid gland. The external surface of the masseter muscle is covered in the greater part of its extent only by the skin and fascia; it is, however, overlapped above by the zygomaticus, below by the platysma, and behind by the parotid gland, whose duct also crosses it; the branches of the facial nerve and the transversalis faciei artery also rest upon it. Its inner surface overlays the buccinator, from which it is separated by some soft adipose tissue; also the tendinous insertion of the temporal muscle into the coronoid process; and is in intimate contact with the ramus of the jaw.

360. *m. Temporalis* (temporo-maxillaris) is placed at the side of the head, occupying the whole extent of the temporal fossa; it is of considerable size, being broad, thin, and expanded above, where it is attached to the side of the skull, but it becomes thick, compressed, and narrowed to a point below, at its insertion. The fibres of the muscle present a radiating appearance; they are concealed from view by the temporal fascia, which must be removed before they can be seen. It *arises* from the whole of the temporal fossa, its fibres being implanted into all that depressed surface which extends from the external angular process of the frontal bone backwards to the root of the mastoid process, and from the curved line marked upon the parietal and frontal bones downwards to the ridge on the sphenoid bone which separates the temporal fossa from the zygomatic. The fibres from this extensive origin converge as they descend, some being directed from before backwards, a considerable number obliquely forwards, whilst those in the middle descend almost vertically; but all terminate in a tendon whose fibres, at first radiating like those of the muscle itself, gradually become aggre-

gated, so as to form a thick flat fasciculus, which is implanted into both surfaces as well as the anterior border of the coronoid process of the lower jaw-bone. The upper part of this tendon is in a great degree concealed by the muscular fibres, many of which descend to be implanted into its external surface, whilst the deep-seated fibres come forward from the lower part of the fossa to be attached to its inner surface; the lower part, or insertion of the tendon, is altogether concealed by the zygoma and the masseter. The muscle is covered and bound down by a remarkably dense firm membrane (*temporal fascia*), which is attached inferiorly to the upper margin of the zygoma, where it is separated from the muscle by some loose adipose and cellular tissue; but higher up, the fascia expands, and becomes closely connected with the muscular fibres, and is attached along the curved line bounding the temporal fossa, where it gives origin to many of the superficial fibres of the muscle. The external surface of the fascia is overlaid above by the aponeurosis of the occipito-frontalis muscle, before by the orbicularis palpebrarum; moreover, two muscles of the ear—the attollens and attrahens, rest upon it, and the temporal artery and vein, with the ascending branches of the facial nerve, cross it as they pass up towards the arch of the skull.

PTERYGO-MAXILLARY REGION.

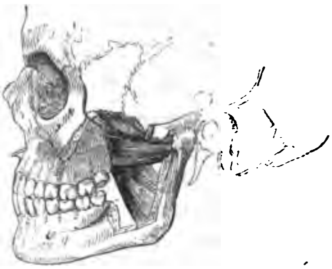
Fig. 87.



361. *m. Pterygoideus internus*, fig. 87, 2, and 88, 2, (pterygo-maxillaris major,) is applied closely to the inner surface of the ramus of the jaw, somewhat as the masseter is to its outside. It is flat and elongated; its form, like that of the masseter, being an oblong square. It *arises* from the pterygoid groove, or fossa, its fibres, tendinous and fleshy, being attached to the inner surface of the external pterygoid plate of the sphenoid bone, and to the grooved surface in the tuberosity of the palate bone which is inserted between the pterygoid plates. From these

points of attachment the muscle inclines downwards, backwards, and outwards, to be inserted into the inner surface of the ramus of the jaw, for about an inch above its angle. The external surface of the muscle rests against the bone, from which it is separated by the internal lateral ligament, and by the dental artery and nerve. Its inner surface, whilst placed in the pterygoid groove, is in contact with the tensor palati muscle, and lower down with the superior constrictor of the pharynx.

Fig. 88.



362. *m. Pterygoideus externus*, figs. 88, 87, 1, (pterygo-maxillaris minor,) is placed deeply in the zygomatic fossa, extending horizontally backwards and outwards from the process of that name to the condyle of the lower jaw. Its form is somewhat triangular, its base corresponding with its origin, and the apex with its insertion. The two extremities are tendinous, the rest of the muscle being a short, thick, fleshy mass, the upper fibres of which descend a little and the lower ascend as they pass between their points of attachment, whilst those in the middle are horizontal. At its base or origin it appears to consist of two fasciculi, separated by a cellular interval; the upper fasciculus is attached to that part of the external surface of the great wing of the sphenoid bone which is near the root of the pterygoid process, the other is attached to the outer surface of the external pterygoid plate, and to a small part of the tuberosity of the palate bone. It is inserted into the fore part of the neck of the condyle of the lower jaw, and also into its inter-articular cartilage.

This muscle, from its position in the zygomatic fossa, is concealed by the coronoid process of the jaw, and the insertion of the temporal muscle; but when the masseter is removed, part of it can be seen between that process and the condyle. Its external surface is crossed by the tendon of the temporal muscle as it passes to the coronoid process, and is further covered by the masseter; the inner surface rests against the upper part of the internal pterygoid muscle, whose direction it crosses, also the internal lateral ligament of the lower jaw, and the inferior maxillary nerve: the lower border is free and unattached, the upper is in contact with the great wing of the sphenoid bone, where it forms part of the zygomatic fossa. As the pterygoid muscles diverge to their destinations, they leave between them an angular interval, which transmits the gustatory and dental nerves, and the internal maxillary artery.

Actions.—The lower jaw is elevated by the temporal, masseter, and internal pterygoid muscles, which conspire to this end. If the two first act together, the elevation is direct; but if the two last act, the obliquity of their direction enables them to carry the angle of the jaw a little forwards. The triturating movement is performed exclusively by the external pterygoid muscles. If both act together, they draw the condyles, and therefore the whole jaw, directly forwards, so as to make the lower teeth project beyond the upper; but when only one acts at a given time, it draws the corresponding condyle forwards, the other remaining fixed, and so makes the symphysis of the jaw deviate to the opposite side. A similar movement can be given by the corresponding muscle, and the alternation of these horizontal motions constitutes trituration.

AURICULAR REGION.

363. In the space round the external ear are placed three small muscles, which in the human subject may be considered rudimentary, as they are not required to perform any action. They are attached by small tendons to the fibro-cartilage of the ear, and are quite superficial.

Dissection.—These muscles are generally removed together with the skin, when their dissection is attempted in the usual way by the beginner, who seeks to expose the fleshy part first: better at once reverse the process—seek for the tendons, and take them as guides. For this purpose, draw the pinna or broad part of the ear downwards; a very small tense cord will be felt under the skin, where it is reflected from the head to the ear, running from above downwards to the upper bulging part of the concha. This is the tendon of the attollens. Cautiously divide the skin by an incision drawn over the tendon from below upwards; reflect it to each side, and continue the process thus upwards from the tendon to its muscular fibres, which spread upon the temporal fascia. Proceed in the same way to expose the two other muscles—draw the pinna forwards, and the tendon of the retrahens will be readily perceived where it is inserted into the bulging part of the concha behind. Let a hook be inserted into the extremity of the helix at the point corresponding with the line of the zygoma. When the helix is drawn backwards, the tendon of the attrahens muscle is rendered tense, and can be exposed and dissected as in the previous instances.

364. *m. Superior auris*, fig. 86, 16, (attollens aurem, temporo-auricularis,) is the largest. It arises from the temporal fascia, where it expands on the side of the head; its fibres, though delicate, being broad and radiated. The muscle ends in a compressed tendon, which is inserted into the upper and anterior part of the cartilage of the ear.

365. *m. Posterior auris*, 17, (retrahens aurem, mastoido-auricularis,) consists of two or three thin fasciculi, ranged one over the other; they arise from the mastoid process by short aponeurotic fibres, and are inserted into the back part of the concha.

366. *m. Anterior auris*, 18, (attrahens aurem, zygomato-auricularis,) is a narrow, fleshy, and tendinous fasciculus, which is attached to the temporal fascia above the zygoma, and passes backwards, to be inserted into the fore part of the helix.

ORBITAL REGION.

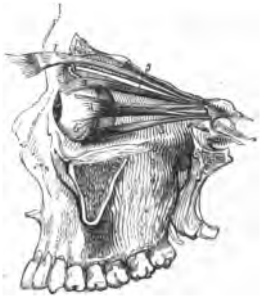
367. This consists of the orbit which lodges the eye, and its appendages. The muscles which it encloses are eight, viz. levator palpebræ, four recti, two obliqui, and tensor tarsi.

Dissection.—It is here taken for granted that the arch of the skull has been previously removed in order to dissect the brain. Now to gain a clear view of the contents of the orbit, it is necessary to remove the greater part of its roof, and the whole of its outer wall. With this intent the malar bone may be sawed through on a level with the floor of the orbit, and as far back as the spheno-maxillary fissure. The orbital plate of the frontal should in the next place be cut through with a chisel along its inner third, and back to the anterior clinoid process: this incision should be continued along the floor of the middle fossa of the skull, close to the outside of the foramen rotundum and ovale, and thence back to the pars petrosa, so as to cut through the great wing of the sphenoid bone and the squamous part of the temporal bone. When this has been done, the whole may be pressed down and detached, by cutting along the base of the skull, from within outwards, the knife being inserted into the fissure thus made. These measures should first be considered, and marked out on the dried skull. A complete lateral view is thus obtained of the divisions of the fifth nerve, of all those in the cavernous sinus, as well as of the parts in the orbit.

Puncture the optic nerve with a coarse needle near the globe of the eye, and push it on into the latter, so as to make a free passage into it, through which you may convey a curved blow-pipe, and with a little air distend the globe; ligature the extremity of the nerve to prevent the air from escaping. Draw the eye-lids forward, fill them with a little cotton, and apply a few points of suture along their margins. The eye-lids and the globe can now be drawn gently forward, which will put all the muscles on the stretch, and their dissection merely consists in taking out cautiously the fat which fills the orbit.

368. The four recti muscles at their origin surround the optic nerve, and at their insertion correspond with the opposite points of the globe of the eye; each of them has a double name, one being founded on its situation, the other on its action.

Fig. 89.



369. *m. Rectus superior*, fig. 89, 2, (attollens,) arises close by the foramen opticum, and beneath the levator palpebræ, 1: it passes over the globe, and is inserted tendinous into the sclerotica, about two lines behind the cornea.

370. *m. Rectus inferior*, 3, (depressor,) *m. rectus internus* (adductor), and *rectus externus*, 4, (abductor,) all arise by a common tendon, which is attached to the bony lamella that separates the foramen opticum from the sphenoidal fissure; but the external rectus has another attachment besides that of the common tendon. Its second head arises from the margin of the sphenoidal fissure, near the superior rectus. Between these heads is a narrow interval, which gives transmission to the third and sixth nerves and the nasal branch of the fifth. The four recti, thus attached posteriorly, pass forwards diverging, and are inserted into the sclerotica, about the same distance from the cornea as the superior rectus.

371. *m. Obliquus superior*, 5, (trochlearis,) arises about a line from the optic foramen at its upper and inner part. From

thence it proceeds towards the internal angular process, and terminates in a round tendon, which passes through a fibro-cartilaginous ring, or pulley, that is attached to the inner margin of the orbit. To facilitate movement, a delicate synovial sheath lines the contiguous surfaces of the pulley and the tendon. At this point the tendon is reflected outwards and backwards, passing between the globe and the superior rectus, to be inserted into the sclerotica, midway between the superior and external recti muscles, and nearly equi-distant from the cornea and the entrance of the optic nerve.

372. *m. Obliquus inferior*, 6, arises from a minute depression in the orbital plate of the superior maxillary bone just within the inferior margin of the orbit, and close by the external border of the lachrymal groove. The muscle inclines outwards and backwards between the inferior rectus and the floor of the orbit, and ends in a tendinous expansion, which passes between the external rectus and the globe to be inserted into the sclerotica, at its external and posterior aspect.

Besides the six muscles here described as the special motors of the globe of the eye, two others are found within the orbit, and have been already described with the muscles of the eye-lids, to which they belong, viz. the levator palpebræ and tensor tarsi (sect. 343, 344).

Actions.—The four straight muscles are attached in such a way at opposite points of the circumference of the globe of the eye, that, when the parts are viewed together in their natural position, the muscles with the globe represent a pyramid whose summit is at the optic foramen and base at the points of insertion. Now, as these points are anterior to the transverse diameter of the globe, and as each muscle, to reach its insertion, curves over the convexity of the eye, it will be obvious that when in action their effect must be to turn or rotate the globe, so that the cornea will be directed by them either upwards or downwards, outwards or inwards, as their names severally express. This will be better seen if a needle be inserted into the middle of the cornea, and each muscle be pulled by holding it with a pair of forceps near its origin. If any two recti act together, the cornea will be turned to a point intermediate between those to which they direct it separately. Thus the superior and external recti acting together turn the cornea upwards and outwards, the inferior and internal recti downwards and inwards. By this succession, combination, and alternation of action, the recti are enabled to direct the eye with the minutest precision to every point in the field of view. Sir E. Home attributes to them also the power of compressing the globe so as to lengthen its antero-posterior diameter, thereby becoming the principal means of its adjustment to seeing at different distances.

What is the action of the obliqui? They were at one time supposed to serve as antagonists to the recti, and to draw forward the globe of the eye, after it had been retracted into the orbit by the latter muscles. This cannot be the case; for they exist in animals in which the globe cannot be retracted, and they receive no increase of developement in those which possess a large retractor muscle in addition to the recti. The obliqui perform all the involuntary and revolving movements, the recti all those which are governed by the will. When volition is suspended in sleep, or during coma, the cornea is observed to be turned upwards under the upper eye-lid; and when the lid descends, as in winking, the globes revolve upwards at the same time, and for a special purpose. When the eye-lid descends like a curtain over the globe, it brings down any extraneous matters which may have lodged upon it. These would necessarily be collected into a line across the centre of the cornea and obstruct vision; but by the revolving motion, the cornea is carried upwards as the lid descends, and all extraneous matters are brushed away.

Muscles of the Neck.

373. The muscles of the neck are numerous, and at first sight appear to be rather complex in their distribution. They may be grouped into sets as follow:—

1. The muscles placed along the side of the neck being, at least comparatively, superficial, viz. the platysma myoides, and sterno-mastoideus .	Superficial region.
2. Those placed obliquely at the upper part of the neck, viz. digastricus, stylo-hyoideus, stylo-glossus, stylo-pharyngeus	Sub-maxillary region.
3. Muscles placed towards the fore part, and above the os hyoides, viz. mylo-hyoideus, genio-hyoideus, hyo-glossus, genio-hyo-glossus, and lingualis	Genio-hyoidregion.
4. The muscles placed in front, lying beneath the os hyoides, viz. sterno-hyoideus, sterno-thyroideus, thyro-hyoideus, crico-thyroideus, and omo-hyoideus	Sterno-hyoid region.

5. Those placed deeply at the side and front of the vertebral column, viz. scaleni, rectus lateralis, rectus anticus, major and minor, and longus colli	Anterior vertebral region.

All these are in pairs at each side.

Dissection of the Neck.—The head being allowed to hang over a block placed behind the neck, and the side of the latter being turned forward, we may proceed to examine it as a surgical region. In this view it presents itself to our notice as a quadrilateral space, bounded below by the clavicle, above by the margin of the jaw, and a line continued back from it to the mastoid process; before, by the median line, extended from the chin to the sternum, and behind, by another from the mastoid process to near the external end of the clavicle.

The *dissection may be commenced* by making two incisions through the skin, corresponding with the two last-mentioned lines. Now, the whole space is divided into two triangles by the sterno-mastoid muscle, which runs diagonally through its area, each of which requires a particular examination; for in the upper triangle, whose base corresponds with the margin of the jaw, and whose apex lies at the sternum, is lodged the carotid artery; and in the external and inferior space, the base of which corresponds with the clavicle, the subclavian artery is placed in the situation in which it may be compressed or tied. When *proceeding with the dissection,* an incision may be made through the skin in the course of the sterno-mastoid, so that the angular flaps thus marked out may be raised and reflected, one upwards over the face, the other down on the chest. This will expose the platysma in its entire extent; the direction of its fibres should be carefully considered in reference to the operation of opening the jugular vein. If the point of the lancet be directed upwards and forwards in the course of its fibres, it will merely make a fissure between them, and when withdrawn they will contract, and close over the wound in the vein, so that the operation is rendered ineffectual, and probably an ecchymosis will be produced. But if it be directed upwards and outwards, the fibres will be cut across and retract, so as to expose the vein and the aperture made in it.

The platysma should be reflected from below upwards over the face, beginning at the clavicle, by which means, particularly if the trapezius be turned back, the cervical fascia will be fully exposed. When the platysma is dissected off the sterno-mastoid, we see lying on it the ascending nerves of the cervical plexus, and passing downwards the descending set. In the area of the superior triangular space will be found the submaxillary gland and digastric muscle: and lower down the sheath of the vessels, enclosing the carotid artery, jugular vein, and vagus nerve. On the sheath the descendens noni lies, and behind it the sympathetic nerve.

The inferior triangular space will be found divided into two parts by the omo-hyoideus passing across it; the upper division containing the cervical plexus, the lower the axillary plexus and the subclavian artery. The upper belly of this muscle also divides the superior space by passing across the sheath of the vessels; all that part of the carotid below it being deeply seated and covered by muscles, whilst the rest is comparatively superficial. When these parts have been examined, the jaw may be sawed through, both at the symphysis of the chin, and at the margin of the masseter muscle, the mylo-hyoideus having been previously detached from its connexion with the os hyoides. These being removed, the side of the tongue, the gustatory nerve, the sublingual gland, and the hypo-glossal nerve, are brought into view, together with the muscles.

When describing the fascia, mention has been made of the fact, that processes pass inwards, investing the muscles in front of the larynx; similar lamellæ are also extended to the cervical glands. Now, enlargements of the latter often simulate the characters of aneurismal tumours of the contiguous artery, so that their diagnosis is difficult. The facts, however, just alluded to, will go some way to clear up the difficulty; for if the patient be desired to make an effort as if to swallow, the larynx will ascend, and with it the fascia, by reason of their connexion, and the latter will at the same time draw up the tumour, if it be merely glandular; when the effort ceases, these parts will again subside. The fascia is described sect. 469, 470.

SUPERFICIAL CERVICAL REGION.

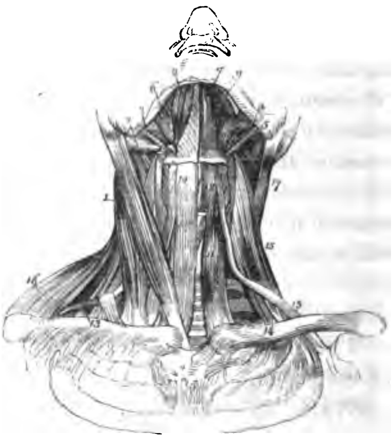
Two muscles are extended beneath the skin, along the side of the neck:—

374. m. *Platysma myoides*, fig. 86, 19, (cutaneus,—peaucier,) is a flat thin plane of muscular fibres, forming a fleshy membrane, placed immediately beneath the skin of the neck. Its fibres, which are pale and thin in their entire extent, commence in the cellular tissue, covering the upper part of the deltoid and pectoral muscles, and thence proceed upwards and inwards over the clavicle, and upon the side of the neck, gradually converging to the muscle of the opposite side. They pass over the margin of the inferior maxillary bone; some of them adhere to its ex-

ternal oblique line, becoming blended with the triangularis oris, others incline inwards and mingle with those of the opposite platysma in front of the symphysis of the jaw, whilst others farther back are prolonged upon the side of the cheek as far as the angle of the mouth, where they become blended with the muscles in that situation. This part of the muscle, from its effect on the mouth, was formerly called *risorius Santorini.* In some subjects, a few fibres may be traced higher up on the face to the zygomatici muscles, or even to the margin of the orbicularis palpebrarum. The platysma is covered by the skin, to which it is connected by cellular tissue, usually called the superficial fascia of the neck. It covers slightly the pectoralis major, its upper or clavicular portion, as well as the clavicular part of the deltoid, also the clavicle; higher up it lies upon the sterno-mastoid muscle, external jugular vein, the sheath of the great cervical vessels, the submaxillary gland, labial artery, the body of the jaw-bone and side of the cheek.

375. *m. Sterno-cleido-mastoideus*, fig. 90, 1, is extended, as it were, diagonally across the side of the neck, from the top of the sternum to the mastoid process behind the ear; it is thick and rounded at the middle, so as to be at all times prominent, particularly when in action, but becomes broader and thinner at its extremities. It *arises* from the top of the sternum and inner third of the clavicle, the attachment to the former being by a thick, rounded fasciculus, composed of tendinous fibres at its cutaneous aspect, the rest being fleshy. The clavicular portion is flat, and in form somewhat triangular; it is composed of fleshy and aponeurotic fibres, which pass perpendicularly upwards, whilst the sternal part inclines backwards as it ascends, so that both become inseparably blended, below the middle of the neck, into a thick rounded

Fig. 90.



muscle, which is finally inserted into the anterior border and external surface of the mastoid process, and for some way into the rough ridge behind it, by aponeurotic fibres. The external surface of the muscle is covered by the platysma in the middle three-fifths of its extent, its upper and lower portions being left uncovered, so that its sternal origin and its insertion are covered only by the fascia and skin ; part of the parotid gland overlaps it superiorly. In the middle it is crossed by the external jugular vein, and by the ascending superficial branches of the cervical plexus. It rests on part of the sterno-hyoid and sterno-thyroid muscles, crosses the omo-hyoid muscle, covers the cervical plexus of nerves and great cervical vessels in the lower part of the neck, and in the upper part the digastricus and stylo-hyoideus muscles, and spinal accessory nerve, which pierces it. The two sterno-cleido-mastoidei are placed closely together at their sternal attachment, whilst their insertions are separated by the whole breadth of the basis of the skull.

Actions.—The lower part of the platysma can exert no action of much importance in the human subject; it may be considered as a rudiment of that broad fleshy lamella which is placed beneath the skin in the lower animals. The upper part of the muscle may assist in depressing the angle of the mouth, and when its action is general the skin of the neck becomes slightly creased or wrinkled. When the two sterno-mastoid muscles act together, they bow the head forwards; but if one acts by itself, it is enabled, by the obliquity of its direction, to turn the head, and therefore the chin, to the opposite side. It has been said that this muscle can draw the head down to its own side, approximating the ear to the shoulder. But to effect this, its action must be combined with that of some other muscle, as the splenius; for then, as the latter arises from the spinous processes, whilst the former comes from the sternum, both converging to the mastoid process, the head may, by their combined effort, be drawn down to the point intermediate between their attachments, namely, to the shoulder.

SUB-MAXILLARY REGION.

376. *m. Digastricus*, fig. 90, 2, 2, (biventer maxillæ, mastoido-mentalis,) is placed in a curved direction across the upper part of the neck, a little below the margin of the jaw-bone. As its name implies, it consists of two fleshy bellies, united by a

rounded middle tendon, each of which parts has a separate attachment. The posterior belly, which is longer than the anterior, arises from the digastric groove in the temporal bone behind the mastoid process: the anterior is inserted into a slight depression at the inside of the lower border of the jaw-bone, close to its symphysis, whilst the tendon is connected with the side of the os hyoides by a dense fascia, and by the fleshy fibres of the stylo-hyoideus muscle, 3, through which the tendon passes. The posterior, or sub-mastoid portion, descends inwards and forwards, gradually tapering until it ends in the tendon; the anterior, or sub-mental portion, arising from the tendon, passes upwards and forwards, gradually widening towards its insertion, where it is in contact with the digastricus of the opposite side. Now, as the side of the os hyoides is beneath both points of attachment, and nearly in the middle between them, the fleshy bellies, where they end in the tendon, must form an angle with one another, which, if stretched, the whole muscle will describe a curve. The anterior belly lies immediately under the skin, and rests on the mylo-hyoideus muscle, being in close contact with its fellow of the opposite side; the posterior is covered by the sterno-mastoid, and crosses both carotid arteries and the jugular vein. Its upper margin bounds the sub-maxillary gland.

377. *m. Stylo-hyoideus,* figs. 90, 3; 91, 1, lies close to the posterior belly of the preceding muscle, being a little behind and beneath it. It *arises* from the middle of the external surface of the styloid process of the temporal bone, from which it inclines downwards and forwards, to be inserted into the os hyoides at the union of its great cornu with the body. Its fibres are divided into two fasciculi near its insertion, for the transmission of the tendon of the digastricus. Its upper part lies deeply, being covered by the sterno-mastoid and digastricus muscles, and by part of the parotid gland: the middle crosses the carotid arteries; the insertion is comparatively superficial.

378. *m. Stylo-glossus,* figs. 90, 4; 91, 2, lies higher up, and is also shorter than any of the three muscles which arise from the styloid process. Its direction is forwards and a little downwards, so that it becomes nearly horizontal. It *arises* from the styloid process near its point, and from the stylo-maxillary ligament, to which the greater number of its fibres are attached

by a thin aponeurosis, and is inserted along the side of the tongue, its fibres expanding somewhat as they become blended with its substance; they overlay those of the hyo-glossus muscle.

379. *m. Stylo-pharyngeus*, figs. 90, 5; 91, 3, is larger and longer than the other styloid muscles, and also more deeply seated; it extends from the styloid process downwards, along the side of the pharynx. It *arises* from the inner surface of the styloid process, near its root, from which it proceeds, downwards and inwards, to the side of the pharynx, where it passes under cover of the middle constrictor muscle, with which its fibres contract some connexion, but are finally prolonged to the posterior border of the thyroid cartilage, into which they are inserted. The external surface of the muscle is, in the upper part of its extent, in contact with the styloid process and stylo-hyoideus muscle and external carotid artery; in the lower, with the middle constrictor of the pharynx; the internal rests on the internal carotid artery and jugular vein; but, in the lower part of its extent, it is in contact with the mucous membrane of the pharynx.

Actions.—The stylo-hyoidei and stylo-pharyngei conspire in elevating the base of the tongue and the bag of the pharynx at the moment when deglutition is taking place, the latter pair of muscles tending at the same time to widen the pharynx. The peculiar mechanism of the digastric muscles enables them to contribute to the elevation of the os hyoides also; for when the two fleshy parts contract together they come nearly into a straight line, and thereby draw up the bone just named, by means of the connexion of the middle tendon of the muscle with its cornu. As a preparatory measure, the mouth must be closed, and the lower jaw fixed, which is one of the first steps in the process of deglutition. If the os hyoides be kept down by the sterno-hyoideus, the anterior belly of the digastricus will serve to depress the lower jaw. The stylo-glossi muscles retract the tongue; they also act on its margins, and elevate them; if the genio-hyo-glossi fig. 91, 7, come into action at the same time, and draw down its raphé, or middle line, its upper surface will be converted into a groove, fitted to convey from before backwards to the fauces any substance required to be swallowed.

GENIO-HYOID REGION.

380. *m. Mylo-hyoideus*, fig. 90, 6, is a flat, triangular muscle, placed immediately behind the anterior belly of the digastricus, and extended from the inside of the maxilla inferior to the os hyoides; its base, or broader part, being above, the apex being below. It *arises* from the mylo-hyoid ridge, along the inner surface of the lower jaw. The posterior fibres incline obliquely forwards as they descend to be inserted into the body of the os hyoides; the rest proceed, with different degrees of obliquity, to join at an angle with those of the corresponding muscle, forming, with them, a sort of raphé along the middle line, from the symphysis of the jaw to the os hyoides. The external surface of the mylo-hyoideus (which in the erect position of the head is inferior) is covered by the digastricus and sub-maxillary gland; the internal, which looks upwards and inwards to the mouth, conceals the genio-hyoideus and part of the hyo-glossus and stylo-glossus, and also the gustatory nerve; its posterior border alone is free and unattached, and behind it the duct of the sub-maxillary gland turns in its passage to the mouth.

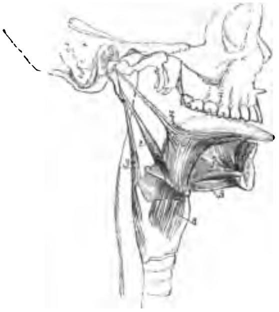
The two muscles of this name, by their junction in front, and by the inclination of the plane which they form, support the mucous membrane of the mouth and the tongue, constituting a muscular floor for that cavity.

381. *m. Genio-hyoideus*, fig. 90, 7; fig. 91, 5, is a narrow, rounded muscle, concealed by the preceding, and lying close to the median line. It *arises* from the inside of the symphysis of the chin (its inferior sub-mental tubercle), and thence descends (separated from the corresponding muscle only by a narrow cellular interval), to be inserted into the body of the os hyoides. This pair of muscles lies between the mylo-hyoideus and the lower or free border of the genio-hyo-glossus.

382. *m. Hyo-glossus*, fig. 90. 8, is a flat, thin band of muscular fibres, extended upwards upon the side of the tongue from the lateral portion of the os hyoides. It *arises* from the great cornu of the os hyoides its whole length, and from part of the body of that bone. From this the muscular fibres incline upwards and outwards, to be inserted into the side of the tongue, where they expand, becoming blended with its substance: the direction of this muscle is almost vertically upwards, and that of

the stylo-glossus horizontally forwards, so that they decussate upon the side of the tongue.

Fig. 91.



383. *m. Genio-hyo-glossus*, fig. 91, 7, is so called from its triple connexion with the chin, os hyoides, and tongue. The muscle forms a flat, triangular plane of fleshy fibres, placed vertically in the median line, the apex of the triangle being represented by its origin from the inside of the symphysis of the lower jaw, the base by its insertion along the whole length of the tongue from its point to its root, for the fibres spread out radiating like the ribs of a fan; one of the sides (the lower one) corresponds with the border which extends from the symphysis to the os hyoides, the other (upper and anterior) with the frænum linguæ. Its inner surface is in contact with the corresponding muscle, the external being covered by those last described. It *arises*, by a short, pointed tendon, from the superior sub-mental tubercle on the inside of the symphysis of the chin. To this the fleshy fibres succeed and diverge from one another, the inferior ones passing down to the os hyoides, the anterior forwards to the tip of the tongue, and all the rest proceeding with different degrees of obliquity to the under surface of the tongue, with which they are blended in its entire length from base to apex. The internal surface of the muscle is in contact with that of its fellow, from which it is at first separated slightly by some cellular tissue, but both become closely adherent towards their termination. The external surface is in contact with the lingualis, hyo-glossus and stylo-glossus, the sub-lingual gland, and lingual artery.

384. *m. Lingualis*, fig. 90, 9, is a thin, narrow band of fleshy fibres, extended along the under surface of the tongue in its entire length. It lies close to the outer side of the genio-hyo-glossus, between it and the hyo-glossus; one extremity of its fibres is connected to the os hyoides, and the other prolonged to the tip of the tongue, being blended inseparably with its substance.

Actions.—The muscles that pass from the jaw-bone to the os hyoides are ordinarily employed in elevating the latter, and with it the base of the tongue, more particularly in deglutition. The genio-hyoglossi, by means of their posterior and inferior fibres, can draw up the os hyoides, at the same time bringing it and the base of the tongue forwards, so as to make its apex protrude beyond the mouth. The anterior fibres will, subsequently, act in retracting the tongue within the mouth. The mylo-hyoidei may be compared to a movable floor or bed, which closes in the inferior and anterior part of the mouth, at the same time serving to sustain the body of the tongue. The linguales resemble retractor muscles: they shorten the tongue, and draw its apex downwards, so as to make its dorsum convex.

STERNO-HYOID REGION.

385. *m. Sterno-hyoideus*, fig. 90, 10, lies at the fore part of the neck, close to the middle line, and immediately beneath the skin and fascia, being extended from the thoracic surface of the sternum to the os hyoides. It *arises* from the first bone of the sternum (its thoracic surface), from the posterior clavicular ligament, and from the cartilage of the first rib. It forms a flat, narrow band of muscular fibres, which ascends, nearly in contact with its fellow or corresponding muscle, to be inserted into the lower border of the body of the os hyoides. It is concealed below by the sternum and sterno-mastoid, higher up it is concealed only by the skin and fascia. It lies on the sterno-thyroideus muscle, which it partly conceals; its inner border is in contact with that of the corresponding muscle, and the outer one with the superior part of the omo-hyoideus.

386. *m. Sterno-thyroideus*, fig. 90, 11, broader and shorter than the preceding, behind which it lies, *arises* from the thoracic surface of the first bone of the sternum, lower down than the sterno-hyoideus, from which it ascends, diverging a little from the corresponding muscle, to be inserted into the oblique line on the side of the ala of the thyroid cartilage. The greater part of its anterior surface is concealed by the sternum and the preceding muscle, as well as by the sterno-mastoid; the posterior rests on the vena innominata, the lower part of the common carotid artery, the trachea, and the thyroid gland.

387. *m. Thyro-hyoideus*, fig. 90, 12; fig. 93, 8, appears like a continuation of the preceding muscle, as it arises from the oblique line on the side of the thyroid cartilage, and thence

passes up to be inserted into the lower border of the great cornu of the os hyoides. It is concealed by the sterno-hyoid and omo-hyoid muscles, and rests on the ala of the thyroid cartilage, and on the thyro-hyoid membrane.

388. *m. Crico-thyroideus*, fig. 93, 9, is a remarkably short muscle, placed below the preceding, and, as its name implies, is attached to the cricoid and thyroid cartilages; its direction being obliquely upwards and outwards, diverging from its fellow of the opposite side. By this arrangement the crico-thyroid membrane is left uncovered, except by the skin and fascia, where it is to be punctured in the operation of laryngotomy. This muscle is concealed by the sterno-hyoideus and sterno-thyroideus.

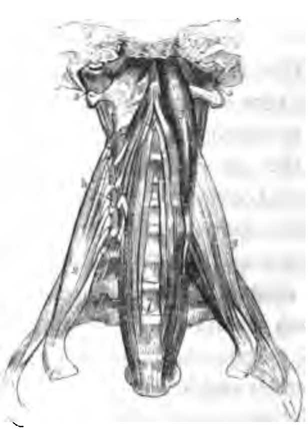
389. *m. Omo-hyoideus*, fig. 90, 13, (scapulo-hyoideus,) is in structure a digastric muscle, as it consists of two bellies, united at an angle. One of these (the upper and inner one) lies close to the external border of the sterno-hyoideus muscle, and is covered only by the platysma and fascia; the other is deeply seated, being concealed, in the greater part of its extent, by the clavicle and sterno-mastoid. It *arises* from the upper border of the scapula, near the supra-scapular notch, and from the ligament which crosses it. From thence the muscle, forming a narrow, flat fasciculus, inclines forwards across the root of the neck, where it suddenly changes its direction, ascending almost vertically, to be inserted into the lower border of the os hyoides, at the union of its body and cornu. The two parts of the muscle here described form an angle, where they lie behind the sterno-mastoid, and are connected to each other by a tendon, which varies much in length and form in different subjects. The tendon is enclosed within two lamellæ of the deep cervical fascia, which, after forming a sort of sheath for it, are prolonged down and become attached to the cartilage of the first rib. It is by this mode of connexion that the angular position of the muscle is maintained.

Actions.—All the individuals of this group of muscles take their fixed point below, and therefore conspire in being depressors of the larynx and os hyoides, for they draw down these parts as deglutition is being performed. As a preparatory measure to swallowing, the pharynx is drawn up, so also is the os hyoides; and, moreover, as a means of security, the larynx at the same moment is made to ascend, so as to be brought under cover of the epiglottis. After the ascent has been effected, the parts do not return to their original position by the mere relaxation of the elevators; they are drawn down by the action of the five muscles just described. The thyro-hyoideus is the only one of them that can act as an elevator; for when the os hyoides ascends, this muscle can draw upwards the thyroid cartilage with it.

VERTEBRAL REGION (LATERAL).

390. *m. Scalenus anticus*, fig. 90, 14; fig. 92, 1, lies deeply at the side of the neck, behind and beneath the sterno-mastoid muscle. It *arises* by a flat, narrow tendon, from the inner border and anterior surface of the first rib, from which its fleshy fibres ascend vertically, to be inserted into the anterior tubercles of four cervical vertebræ, from the third to the sixth inclusive. The lower part of the muscle separates the subclavian artery and vein. It is overlapped by the sterno-mastoid muscle (a small part only projecting behind its outer border), and crossed by the omo-hyoideus, with which and the clavicle it bounds an angular interval, in the area of which lie the subclavian artery and commencement of the axillary plexus of nerves.

Fig. 92.



391. *m. Scalenus posticus*, fig. 90, 15; fig. 92, 2, is larger and longer than the preceding muscle, from which it is separated below by the subclavian artery, and above by the cervical nerves, as they issue from the inter-vertebral foramina. It *arises* from the first rib, about an inch behind the other muscle of the same name, and also from the second near its tubercle. The fleshy fibres ascend along the side of the vertebral column, and are inserted, by tendinous processes, into the posterior tubercles of all the cervical vertebræ except the first. The two origins of the scalenus posticus are separated at first by a cellular interval, which has given occasion to the division of the muscle

into two parts, the larger one being, from its situation, named *scalenus medius*, the smaller the *scalenus posticus*.

Actions.—These muscles draw down the transverse processes of the cervical vertebræ, and thereby bend that part of the spinal column to one side. The inter-transversales, 8, and rectus lateralis, 5, of each side act in the same way, all conspiring to incline the head as well as the vertebræ laterally. This movement may be alternated by bringing the opposite muscles into action. If both act together, the head and spine will be maintained erect. When the scaleni take their fixed points above, they draw on the first ribs, rendering them fixed, as a preparatory step to making a forcible inspiration.

VERTEBRAL REGION (ANTERIOR).

This includes the muscles placed in front of the spine upon the cervical and upper dorsal vertebræ; viz. the rectus capitis anticus major and minor, with the longus colli.

392. *m.* ***Rectus capitis anticus major***, fig. 92, 3, appears like a continuation of the scalenus anticus, being prolonged upwards from the points at which it ceases. This muscle *arises* from the anterior tubercles of the transverse processes of four cervical vertebræ (from the third to the sixth inclusive) by so many tendinous processes. It ascends, converging somewhat to the corresponding muscle, and is inserted into the basilar process of the occipital bone, in front of the foramen magnum. It is tendinous and fleshy in its structure; its anterior surface supports the pharynx, the sympathetic nerve, and the great cervical vessels, viz. the carotid artery, the jugular vein, and the vagus nerve, or rather the sheath which encloses these. Its posterior surface overlays part of the longus colli, and the rectus anticus minor, also the articulation of the second with the first vertebra and of the latter with the occipital bone.

393. *m.* ***Rectus capitis anticus minor***, fig. 92, 4, is a short, narrow muscle, lying behind the superior part of the preceding. It *arises* from the fore part of the lateral mass of the atlas and a little from the root of its transverse process, and is inserted into the basilar process, between the margin of the foramen magnum and the preceding muscle, but a little farther out than the latter.

394. *m.* ***Rectus lateralis***, fig. 92, 5, is a short flat muscle placed between the transverse process of the atlas and the occipital

bone. It *arises* from the upper surface of the transverse process of the atlas, and is inserted into the rough ridge, external to the condyloid process of the occipital bone. It completes the series of the inter-transversales muscles, 8; its anterior surface supports the internal jugular vein at its exit from the skull, and the posterior is in relation with the vertebral artery.

395. *m. Longus colli* rests on the fore part of the spinal column, from the atlas to the third dorsal vertebra. It is narrowed and pointed at its extremities, but becomes wider along its middle part; it is compressed throughout, and appears to consist of two portions, differing in length and in the direction of their fibres. One of these, fig. 92, 6, superior and external to the other, *arises*, by a narrow, tendinous process, from the anterior tubercle of the atlas, from which its fibres descend obliquely outwards, to be inserted into the fore part of the transverse processes of the third, fourth, and fifth cervical vertebræ. The other part of the muscle commences at the depression in the body of the axis; its fibres also arise from the bodies of the third and fourth cervical vertebræ, and from the transverse processes of the fourth and fifth. The tendinous and fleshy fibres, 7, derived from these attachments pass vertically downwards, to be inserted into the bodies of the three lower cervical vertebræ and the three upper dorsal. The two muscles of this name are smooth and compressed at their anterior aspect. They consist of tendinous and fleshy fibres; the former occupy the anterior surface, particularly at the extremities; some are also deep-seated; and the fleshy fibres, which are in general short, are placed obliquely between them. They support the pharynx, the œsophagus, the sympathetic nerves, the carotid arteries, and the eighth pair of nerves.

Actions.—The anterior recti muscles are the natural antagonists of those placed at the back of the neck. They restore the head to its natural position when it has been drawn backwards by the posterior muscles, and, continuing their effort, bow it slightly forwards. Beneath the base of the skull, and at opposite points, we find short and straight muscles, two in front (recti antici), two behind (rectus posticus, major and minor), one on each side (rectus lateralis), which are the direct agents in the restricted motions that take place between the head and the first vertebra. The horizontal movement of the head is effected by the obliqui, particularly by the inferior one. It is obvious, that if it acted by itself, the first vertebra only would be rotated on the second, the head remaining unmoved; but the recti minores and the superior oblique muscle conspire to fix the skull on the first vertebra, and thereby communicate to it any movement impressed on the latter by the inferior oblique muscle.

PHARYNGEAL REGION.

396. We have here the following muscles forming a hollow bag, the pharynx; viz. constrictor superior, constrictor medius, constrictor inferior, together with the stylo-pharyngeus and palato-pharyngeus.

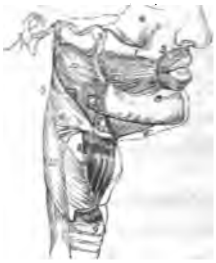
Dissection.—After having examined the sides and fore part of the neck, when you are about to dissect the pharynx, larynx, and soft palate, proceed as follows:—Cut across the trachea and œsophagus a little above the sternum, and draw both together forwards. There then can be no difficulty in detaching the pharynx from the muscles in front of the vertebral column, as they are merely connected by loose cellular tissue. When this is done, a piece of cloth should be carried deeply to the base of the skull, and drawn across the pharynx, to serve as a retractor whilst the saw is being used. The edge of the saw should, in the next place, be applied behind the styloid processes, so as to cut through the base of the skull, from below upwards, thereby detaching the face, with the pharynx and larynx all pendent from beneath it. The pharynx should be stuffed, to render its muscles tense. When its exterior is sufficiently examined, a longitudinal slit made along the middle line posteriorly, will expose its cavity, and that of the mouth and larynx.

397. The pharynx is a musculo-membranous tube, extended from the centre of the base of the skull to the œsophagus, with which it is continuous. It lies behind the nasal fossæ, the soft palate, the isthmus of the fauces, and the larynx, which open into it,—before the vertebral column, and between the great vessels of the neck. The posterior and lateral parts of the pharynx are loosely connected to the adjacent structures by cellular tissue, but anteriorly it presents the several apertures that lead into the nose, mouth, and larynx. Its structure is made up, externally, of muscular fibres, (disposed in a very peculiar way, being formed into three lamellæ on each side, partially overlapping one another,) and, internally, of mucous membrane,

prolonged from the mouth and nares. These layers of muscle are called the constrictors of the pharynx.

398. *m. Constrictor inferior*, fig. 93, 10, arises from the external surface of the cricoid cartilage, and from the oblique ridge on the side of the great ala of the thyroid. From these attachments the fibres curve backwards and inwards, converging to those of the corresponding muscle of the opposite side, with which they unite along the middle line. The direction of the inferior fibres is horizontal, concealing and overlapping the commencement of the œsophagus; the rest ascend with increasing degrees of obliquity, and overlap the lower part of the middle constrictor.

Fig. 93.



399. *m. Constrictor medius*, fig. 93, 11, is smaller than the preceding: it *arises* from the side of the great cornu of the os hyoides, also from its lesser cornu, and the stylo-hyoid ligament. From these points of attachment the fibres proceed backwards, diverging from one another, and are blended with those of the corresponding muscle along the middle line. The lower fibres incline downwards, being concealed by the inferior muscle; the middle run transversely; the rest ascend, overlap the superior constrictor, and are prolonged, by a narrow slip of white fibres, to the basilar process of the occipital bone.

400. *m. Constrictor superior*, fig. 93, 12, is attached slightly to the side of the tongue, and to the extremity of the mylohyoid ridge, also to the pterygo-maxillary ligament, 2, and the lower third of the internal pterygoid lamella. From these different points the fibres of the muscle curve backwards, becoming blended with those of the corresponding muscle along the middle line, and are also prolonged, by means of the posterior aponeurosis, to the basilar process of the occipital bone. Thus, by the peculiar mode of attachment of these muscles, the bag of the pharynx is completed on the sides and posteriorly, and left open in front; and by the connexion of the upper constrictor with the pterygo-maxillary ligament, and of the latter with the buccinator, a continuous smooth surface is established from the

commissure of the lips along the side of the mouth and fauces. Besides these, we find at each side, in the pharynx, two other muscular fasciculi, one being derived from the stylo-pharyngeus, 5, which is insinuated between the adjacent borders of the superior and middle constrictor, and which has been already described. (Sect. 379.) The other lies more internally, being the palato-pharyngeus, which shall be described with the muscles of the palate. (Sect. 406.) It may be observed, that as the lateral attachment of the superior constrictor is no higher than to about a third of the internal pterygoid plate, whilst the insertion is into the basilar process, the fibres of the muscle, as they pass between these points, leave a small interval, in which the mucous membrane is uncovered.

Actions.—The pharynx is drawn up when deglutition is about to be performed, and at the same time dilated in opposite directions. It is widened from side to side by the stylo-pharyngei, which are farther removed from one another at their origin than at their insertion, and can thereby draw outwards the sides of the cavity; and as the os hyoides and larynx are carried forwards in their ascent, the breadth of the pharynx from before backwards is also increased, inasmuch as its fore part is drawn in the same direction, by reason of its connexion with the larynx. When the morsel of food is propelled into the pharynx, the elevator muscles relax, the bag descends, and then the fibres of its own muscular wall begin to contract, and force the mass down into the œsophagus.

When we contrast the structure of the pharynx with that of the œsophagus, comparing the complex arrangement observable in the one with the simplicity of the other, we see abundant evidence of its being intended for something more than a mere recipient and propellent of such matters as are to be conveyed to the stomach. It exerts an important influence in the modulation of the voice, being brought into action in the production of its higher tones.

The description of the muscular structure of the pharynx may be given briefly as follows; it may be considered as a single muscle, consisting of two symmetrical halves, united by a raphé posteriorly along the middle line, the union extending from the basilar process to the œsophagus. The superior fibres curve downwards and outwards, to be fixed to the lower third of the internal pterygoid plate, to the pterygo-maxillary ligament and to the mylo-hyoid ridge and side of the tongue; the middle set of fibres, broad, and expanded posteriorly at the line of junction, converge as they proceed forwards to be attached to the cornu of the os hyoides and the stylo-hyoid ligament, and are so disposed, that part is concealed by the succeeding set, whilst others overlap the preceding muscle. The lower fibres proceed forwards in the same way, to be attached to the side of the cricoid and thyroid cartilages. The tube is thus shown to be complete posteriorly and at the sides, being open in front, where it communicates with the nose, mouth, and larynx.

When the pharynx is slit open, we expose the cavities just mentioned, and the apertures which lead into them, as well as the orifices of the Eustachian tubes.

PALATAL REGION.

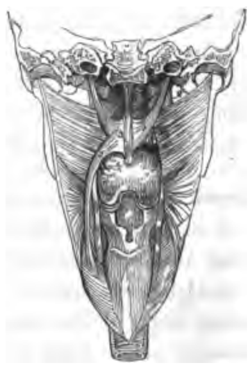
401. The soft or pendulous palate (*velum pendulum palati*) forms a partial and movable curtain between the mouth and the pharynx. Its upper border is straight, and attached to the posterior margin of the palate bones; the lower presents, when viewed from before, a curved or arched border at each side, and in the middle a conical depending process, called the *uvula*. From this, as from a common point of departure, two curved lines will be observed to extend, one at each side, and proceed downwards and forwards, to the side of the tongue. These correspond with the lower or free border of the palate, and mark the limits of the cavities of the mouth and pharynx, for they represent a narrowed or constricted line between them, which is termed the *isthmus* of the fauces. Farther back is another pair of curved lines, one at each side, which also commence at the uvula, and extend downwards and backwards along the sides of the pharynx. They diverge from the preceding curved lines so as to leave between them an angular interval, in which is lodged the *tonsil* or *amygdala*. The curved lines here described are usually called the *arches* of the palate, one pair being anterior to the other, and also more prominent.

The soft palate consists of five pairs of muscles, enclosed by mucous membrane.

Dissection.—When the pharynx has been dissected and examined, as directed in section 396, it may be opened by an incision along the middle line or raphé; this will expose the soft palate; let the uvula be drawn down so as to render it tense; then the small muscles of the palate are at once exhibited by detaching the mucous membrane.

The levatores palati are brought into view by merely removing the mucous membrane from the posterior surface of the soft palate; the circumflexi will be found along the internal pterygoid plates: their aponeuroses, which form the principal support of the soft palate, will be seen in front by dissecting off a thick layer of granular substance, which is continued downwards upon it beneath the mucous membrane.

Fig. 94.



402. *m. Levator palati*, fig. 94, 1, (peri-staphylinus internus, *περι*, about or near, *σταφυλη*, the uvula,) is a long, thin, flat muscle, placed at the posterior surface of the soft palate under cover of the mucous membrane, which arises from the extremity of the petrous portion of the temporal bone, before the orifice of the carotid canal, and from the cartilaginous part of the Eustachian tube. The two muscles converge, as they descend, to become blended at the middle of the soft palate with the other muscles, viz. the levator palati of the opposite side, the azygos uvulæ, and the tendon of the circumflexus palati.

403. *m. Circumflexus*, or *tensor palati*, fig. 94, 2, (peri-staphylinus externus,) presents two portions which differ in their direction and relations. The muscle arises from the small fossa (*navicularis*) at the root of the internal pterygoid plate of the sphenoid bone, also from the anterior surface of the cartilage of the Eustachian tube. From these points it descends perpendicularly between the internal pterygoid muscle and the osseous lamella of the same name, and ends in a tendon, which winds round the hamular process; there it inclines inwards and expands at the same time into a broad aponeurosis, the fibres of which are inserted into the transverse ridge on the under surface of the palate process of the palate bone, and on reaching the middle line they unite with the aponeurosis of the corresponding muscle of the opposite side.

404. *m. Azygos uvulæ*, fig. 94, 3, (palato-staphylinus,) was so called from its having been supposed to be a single muscle; but

there are really two thin fasciculi, separated by a slight cellular interval above, which usually unite towards the lower part. Each arises from the pointed process (spine) of the palate plate, and descends vertically, becoming blended with the other structures in the uvula.

405. *m. Palato-glossus*, or *constrictor isthmi faucium*, fig. 94, 4, inclines from the uvula forwards and outwards to the side of the tongue, where it may be considered as inserted. It is merely covered by the mucous membrane, which it renders prominent, so as to form the anterior arch of the palate.

406. *m. Palato-pharyngeus*, fig. 94, 5, arches downwards and backwards, so as to leave an angular interval between it and the preceding. It commences at the uvula, and descends into the pharynx, being intimately connected with its muscles, and is prolonged as far as the cornu of the thyroid cartilage. It forms the posterior arch or pillar of the velum palati.

Actions.—When the mass of food is carried back towards the fauces, the soft palate is raised nearly to a level with the hard one, and not only serves to prevent the ingesta from passing into the nares, but also, by the contraction of its two arched muscles, assists in pressing them down into the pharynx. The circumflex muscles stretch the palate from side to side, and render it tense, whilst the proper elevators raise it up, and then the palato-glossi and palato-pharyngei, taking their fixed points below, are enabled, by depressing the palate, to force down the food into the cavity ready to receive it.

LARYNGEAL REGION.

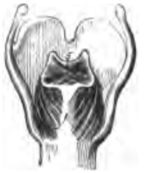
407. We have here several pairs of small muscles, which move the cartilages of the larynx, and are thereby concerned in the production of voice.

Dissection.—When the pharynx has been opened, as directed in the previous dissections, the cavity of the larynx is brought into view. The muscles are readily exposed by removing the mucous membrane which alone conceals them. It is necessary to detach and evert the wing of the thyroid cartilage, in order to see the lateral crico-arytænoid muscle, and the thyro-arytænoid, as seen in fig. 96.

The proper muscles of the larynx may be divided into two sets, viz. dilators and contractors of the rima of the glottis. One pair of the dilators has been already described as being seated outside, viz. the crico-thyroidei (Sec. 388). The others are the crico-arytænoidei postici.

408. *m. Crico-arytænoidei postici*, fig. 95, 1.—These rest posteriorly on the broadest part of the cricoid cartilage, covering by their origin the whole of it, except the middle perpendicular line. Their fibres converge, as they proceed upward and outwards, to be inserted by a narrow process into the bases of the arytænoid cartilages by their external borders. They are merely covered by the mucous membrane.

Fig. 95.

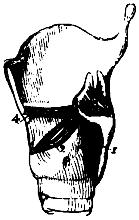


The contractors are the following:

409. *m. Crico-arytænoidei laterales*, fig. 96, 2, are extended obliquely backwards and upwards, from the upper border of the cricoid cartilage on each side, to the base of the arytænoid cartilage. They lie in the interval between the alæ of the thyroid cartilage and the glottis, concealed by the lining membrane.

410. *m. Thyro-arytænoidei*, fig. 96, 4, are placed immediately above the preceding, and are united with them at the point of insertion; they are stretched from before backwards, between the inner surface of the thyroid cartilage at its angle, and the base of the arytænoid cartilages at their anterior border. They lie parallel with the rima.

Fig. 96.



Some muscular fibres may also be traced from near the origin of the preceding, which ascend to the margin of the epiglottis. These are described by some anatomists as *thyro-epiglottidæi*, or *depressores epiglottidis;* but it may be observed, that the closure of the aperture by means of the epiglottis, is effected by the ascent of the whole larynx, by which the rima is drawn as it were under cover of its operculum, and not by the descent of the latter upon it. Some muscular fibres are also occasionally found in the folds of mucous membrane stretched between the arytænoid cartilages and the epiglottis. These have been named *arytæno-epiglottidæi.*

411. *m. Arytænoideus*, figs. 95 ; 96, 5, consists of oblique and

transverse fibres intimately blended together, and laid upon the posterior concave surface of the arytænoid cartilages. Albinus and Winslow, from a consideration of the difference in the direction of its fibres, divided the muscle into three, viz. two oblique, and one transverse; but as all conspire in their actions, and are inseparably connected together, most modern anatomists describe them as a single muscle. The oblique fibres pass from the base of one cartilage towards the apex of the other, crossing in the middle. The transverse fibres pass from one border to the other, and are partly covered by the oblique.

Actions.—The arytænoideus contracts the base or widest part of the rima, rendering it an elongated chink, and is therefore the direct antagonist of the posterior crico-arytænoid muscles, which draw the basis of the cartilages outwards, and widen the interval between them. These cartilages are, on the contrary, drawn forwards (and the antero-posterior extent of the aperture thereby diminished) by the lateral muscles, which pass to them from the cricoid and thyroid cartilages. It may easily be shown that the fibres of the thyro-arytænoid muscles are not merely stretched from before backwards, between the cartilages, but that some of them are attached at different points to the chordæ vocales, and so may act as stops on a musical string, limiting the extent of the part which vibrates at a given moment, and thereby modifying the sound.

Muscles of the Back.

412. The muscles placed along the posterior part of the trunk are found to be arranged in layers, or strata, placed one over the other, and differing materially in extent, attachments, and use. The superficial muscles are so broad as to cover all the others; and, as their extent is considerable, their number is proportionably diminished, being only two, viz. the trapezius and latissimus dorsi. We shall here place them in the order in which we find them in our dissections, proceeding from the tegument to the spine and ribs. Those in each group or layer diminish in size as they increase in number.

In the first layer are the trapezius and latissimus dorsi.

In the second, the rhomboidæi and levator scapulæ.

In the third, the splenii and serrati postici.

In the fourth, the erector spinæ, cervicalis ascendens, transversalis colli, trachelo-mastoideus, and complexus.

In the fifth, the semi-spinales dorsi and colli, recti and obliqui.

In the sixth, the inter-spinales, inter-transversales, multifidus spinæ, levatores costarum.

Dissection.—The subject being turned prone, the chest and abdomen should be supported by blocks, and the arms allowed to hang over the sides of the table. An incision may be made through the integument, along the spinal column, from the occipital protuberance to the sacrum. This should be bounded at its superior extremity by a transverse incision, carried outwards to the mastoid process, and below by another extended along the spine of the ilium. The intervening space may, in the next place, be intersected by two lines; one drawn from the first dorsal vertebra, over the spine of the scapula, the other commencing at the last dorsal vertebra, and carried horizontally outwards.

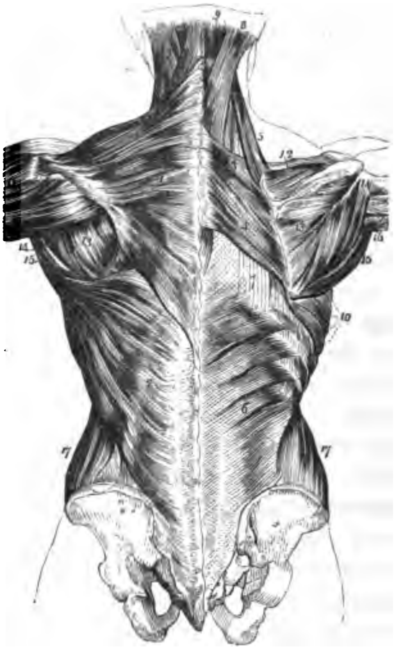
As the space here marked out is' so very extensive, it may be advisable to make an incision obliquely upwards from the last dorsal vertebra to the spine of the scapula, which will correspond with the lower border of the trapezius muscle; and the dissection may be commenced by raising the angular flap of skin thus included, proceeding in the direction of the fibres of that muscle, that is to say, from below upwards and outwards. The other portions of integument should be successively raised, taking care to expose accurately the tendinous fibres where they arise from the spinous processes, as they afford a guide to the fleshy part of the muscle.

When the latissimus and trapezius have been exposed and examined in their entire extent, which will take some time, in consequence of the quantity of surface that is to be gone over, they are to be removed, in order to bring into view the muscles that lie beneath them.

FIRST LAYER OF DORSAL MUSCLES.

413. *m. Trapezius*, fig. 97, 1, (cucullaris, Sœmm.; occipito-dorsi-acromialis,) is a flat thin triangular muscle of considerable extent, which is placed immediately under the skin along the posterior part of the neck, as well as of the back and shoulder. If the two muscles of this name be taken together, they represent a four-sided figure (hence the name), two angles of which correspond with the points of the shoulders, one with the occipital protuberance, and the fourth with the spinous process of

Fig. 97.



the last dorsal vertebra. The trapezius *arises*, 1, from the occipital protuberance, and from about a third of the curved line, extending forwards from it; 2, in the cervical region, from the fibres of the corresponding muscle, both being blended together, and from a tendinous band, called *ligamentum nuchæ;* 3, from the spinous process of the last cervical, and all those of the dorsal vertebræ, as well as from the supraspinous ligament. From these different points of origin the fibres proceed towards their insertion into the clavicle, the acromion process, and the spine of the scapula, following very different directions; those from the occiput inclining downwards and outwards, and those from the lower part of the back upwards and outwards, the obliquity of each set diminishing, so that those intermediate between the two extremes become horizontal. The superior fibres turn forwards a little, and are inserted into the external third of the clavicle; the middle pass transversely to the upper border of the acromion process; whilst the inferior ones ascend to reach the upper border of the spine, to which they are attached as far back as the triangular surface at which it commences. The tendinous fibres by which the muscle arises are rather short along the interval from the last dorsal vertebra as high as the fourth; there they lengthen gradually, but opposite the fourth cervical vertebra they again acquire about the same extent, so that in the interval between these points, the union of the muscular with the tendinous fibres forms a crescent, and if the two muscles be dissected together they will represent an oval.

From the line of union of the two trapezii along the neck, a band of condensed cellular membrane, mixed with tendinous fibres, projects forwards, so as to reach the spinous processes of the vertebræ, forming a septum between the sets of muscles on each side of the middle line. It is attached by its upper extremity to the occipital protuberance, by the lower to the spinous process of the seventh cervical vertebra; its posterior border is blended with the fibres of the trapezii, whilst the anterior is fixed to the spinous processes of the cervical vertebræ. This is usually called *ligamentum nuchæ.* In the human subject it can only be considered as a rudiment of that peculiar elastic band which serves to sustain the weight of the head in the lower animals.

Structure—the trapezius is fleshy in the greater part of its extent, and tendinous at its attachments: relations—by its posterior surface with the skin, beneath which it lies in its entire extent; the anterior one covers part of the complexus, 9, the splenii, 8, levator anguli scapulæ, 5, the supra-spinatus, 12, infra-spinatus, 13, slightly, the rhomboidei, 3, 4, and the upper part of the latissimus dorsi, 2. Where the inferior fibres slide over the triangular surface between the base and spine of the scapula, in order to reach the upper border of the latter, a synovial bursa is interposed.

414. *m. Latissimus dorsi*, fig. 97, 2, (dorsi-lumbo-sacro-humeralis,) as its name implies, is of considerable extent, for it occupies the whole of the posterior part of the lumbar region, and the lower half of the dorsal. It is flat, broad, and thin in the greater part of its extent, but it gradually becomes contracted into a narrow fasciculus towards its insertion into the humerus. It arises by tendinous fibres, 1, from the spinous processes usually of the six lower dorsal vertebræ, from all those of the lumbar region and of the sacrum, and from the supra-spinous ligament; 2, from the external border of the crista ilii (its posterior third); 3, by fleshy digitations from the three or four last ribs, where they are interposed between similar processes of the obliquus externus. The tendinous fibres from the two first lines of origin form, by their intertexture, or union, a broad aponeurosis, from which the fleshy fibres proceed, converging towards the axilla. The fibres at the upper part are the shortest, and pass almost horizontally outwards; those lower down become longer and incline from below upwards, gradually in-

creasing in the degree of their obliquity; finally, those which are attached to the ribs ascend almost vertically. By this convergence, the fibres form a narrow and thick fasciculus, which slides over the inferior angle of the scapula, from which it sometimes receives a small accessory muscle. In this situation it rests on the teres major, 15, which it accompanies towards the axilla, but gradually turns, as it were, on itself, so as to get to the anterior aspect of that muscle, and is inserted into the posterior border of the bicipital groove in the humerus. The flat tendon by which the latissimus dorsi is inserted becomes united, particularly by its lower border, with that of the teres major; it ascends higher than the latter, and also lies nearer to the brachial vessels. It is sometimes connected to the pectoralis major by a fleshy fasciculus extended across the axillary space.

Structure—tendinous along its point of origin from the spine and the ilium, broad and aponeurotic in the lumbar region,—tendinous at its insertion,—fleshy in the rest of its extent, where it lies over the ribs, the angle of the scapula, and the fold of the axilla: relations—it is covered by the trapezius at its dorsal origin, and subcutaneous in the rest of its extent, except where it ascends into the axilla. The anterior surface rests on part of the rhomboideus major, 4, infra-spinatus, 13, teres major, 15; the serratus posticus inferior, 6, and on part of the deep lumbar muscles, 7; its internal border is blended with the fibres of the corresponding muscle, along the middle line, the inferior intermixes with those of the gluteus maximus. The superior border is free, and describes a slight curve, whose concavity looks upwards; the anterior one, also free in the greater part of its extent, slightly overlaps the obliquus externus, 17, below, and higher up the serratus magnus, 10.

Actions.—The trapezius and latissimus dorsi direct or influence the motion of several parts, as must be evident from the extent of their attachments. If the shoulders be fixed, the trapezii muscles acting together, draw the head directly backwards; but if only one of them acts, it inclines the head to the corresponding side. If the head be fixed, the superior part of the trapezius elevates the point of the shoulder, and sustains it in that position, as when a burden is supported upon it; but if the effort required be considerable, or if it must be continued for any length of time, the co-operation of the serratus magnus becomes indispensable. It would appear at first sight, from a mere inspection of the fibres of this muscle, that those in the middle part of it could draw the scapula directly backwards, and the lower ones draw it downwards. This, however, is far from being the fact. As the muscle is attached to the spine of the scapula and the acromion, it will rather, in consequence of the obliquity of the direction of these processes, communicate a certain degree of rotatory motion to the whole bone, by means of which, when the acromion ascends, the posterior angle descends, and the inferior one comes forward; and should the acromion be made to resume its previous position, the inferior angle will move backwards, the superior one upwards. The scapula, then, in its movements, cannot be made to ascend or descend, to go backwards or forwards, in such a way that the direction of its different parts may remain exactly parallel, in their new situations, to those which they had previously occupied:—This bone will, on the contrary, be found to rotate, as it were, on a pivot driven through the centre of its dorsum. To draw the scapula directly backwards requires the combined effort of the trapezius and rhomboid muscles; for, as their fibres decussate, the direction of the one being obliquely downwards, that of the other upwards, the bone, by their combined action, is made to move in the direction of the diagonal of their forces, that is to say, towards the spinal column.

The latissimus dorsi, when it acts on the shaft of the humerus, necessarily draws it downwards, and gives it at the same time a rotatory motion on its own axis, particularly if it had been previously everted, or turned outwards. When the shoulder and arm are rendered fixed, the muscle acts in various ways on the trunk. Thus it assists in forcible inspiration, by drawing on the lower ribs and elevating them. By conspiring with the abdominal and great pectoral muscles, it elevates and sustains the body in the effort of climbing; and when an individual is constrained to resort to the assistance of crutches, the latissimus and pectoralis major are the chief agents in progression.

The trapezius and latissimus dorsi, more particularly the latter, can act under certain circumstances on the spine, preparatory to which the shoulder and arm must become (at least relatively) the fixed points of their attachment. When a man walks close to the margin of a raised foot-path, or of a curb-stone, and happens to incline a little beyond it, the body becomes curved to that side, and by its own weight would carry him over it, if a particular effort were not made to prevent such an occurrence. For this purpose the arm of the opposite side is, as it were, instinctively thrown out somewhat from the body, so as to render the insertion of the latissimus dorsi into that bone, its fixed point of attachment. Thus sustained, the fibres of the muscle are enabled to act on the spine, and, by pulling on those parts of it which are curved, they draw them into a right line with the rest, and so restore the equilibrium of the body.

SECOND LAYER.

Dissection.—To expose the rhomboid muscles and the levator scapulæ, the trapezius must be removed. For this purpose, the fibres of the trapezius may be detached from their connexion with the clavicle and spine of the scapula, and reflected back to the spine. This will be found easier than the usual plan of detaching it from the latter, both because it is there very thin, and also because its fibres are connected with those of the rhomboid muscle. Its dorsal portion conceals the rhomboidei, and part of the latissimus dorsi; and the cervical, the levator scapulæ, the splenius, and complexus. These may be dissected in the course of their fibres, as the trapezius is being reflected back towards the middle line, where it may be separated from its fellow of the opposite side along the cervical region, so as to expose the ligamentum nuchæ. In doing this, insert the edge of the knife under the muscle at the occiput, and draw it from above downwards, in the line of the spinous processes.

The *rhomboideus muscle* (dorso-scapularis) is usually divided into two muscles, though they lie on the same plane, are similar in structure and use, and differ only in size. The two parts of the muscle are separated by a slight cellular interval. It is extended obliquely from the spinous processes of the lower cervical and upper dorsal vertebræ, to the base of the scapula.

415. *m. Rhomboideus minor*, fig. 97, 3, *arises* from the spinous process of the seventh cervical vertebra, and from the ligamentum nuchæ, its fibres being also closely united with those of the trapezius. It inclines downwards and outwards, to be inserted into that part of the base of the scapula which corresponds with the triangular surface from which the spine commences.

416. *m. Rhomboideus major*, 4, three or four times broader than the other, is placed in close contact, and immediately below it. It *arises* from the spinous processes of the four or five upper dorsal vertebræ, and their inter-spinous ligaments, and is in-

serted into that part of the base of the scapula included between its spine and inferior angle. Direction—downwards and outwards: structure—muscular in the greater part of its extent, tendinous at its origin: relations—it is covered by the trapezius in the greater part of its extent, and towards the lower part by the latissimus dorsi; but when the arm is drawn away from the side, a small portion is left uncovered by these muscles, where they diverge at the base of the scapula.

417. *m. Levator anguli scapulæ*, 5, (trachelo-scapularis,) is placed along the side and posterior part of the neck, forming a long and rather thick fasciculus of fleshy fibres. It *arises* from the posterior tubercles of the three or four superior cervical vertebræ, by so many tendinous points. From these the fleshy fibres proceed, being at first slightly separated, but soon united to form a flat muscle, which is inserted into that part of the base of the scapula included between its spine and superior angle. Direction—downwards and a little backwards; structure—fleshy in the greater part of its extent, tendinous at its origin: relations—it is covered by the sterno-mastoid muscle above, and by the trapezius below; it rests on the splenius colli, transversus cervicis,. and serratus posticus superior.

THIRD LAYER.

Dissection.—After having examined the muscles of the second layer, they must be removed in order to gain a view of those underneath them. For this purpose, the rhomboidei may be detached from the base of the scapula, and reflected backwards, which is the easier mode of attaining the end desired, and avoids any risk of raising with them the serratus superior, which is intimately connected with their origin. The aponeurosis of the latissimus dorsi may be divided by an incision carried from above downwards, along its middle; and as the external half is reflected outwards, its intimate connexion may be observed with the obliquus abdominis, along the border of the deep lumbar muscles. The other portion of the aponeurosis may be drawn back towards the spine, by which means the serratus posticus is left untouched. The serrati and their connecting membrane may then be inspected.

418. *m. Serratus posticus superior* (cervici-dorso-costalis) is placed under cover of the rhomboideus; it is flat, and very thin. It *arises* from the spinous process of the last cervical, and from those of two or three upper dorsal vertebræ, by a thin aponeu-

rosis, which inclines downwards and outwards, soon becoming muscular, and is inserted by four fleshy digitations into the bodies of the second, third, fourth, and sometimes fifth ribs, a little beyond their angles. Its direction is obliquely downwards and outwards, resting on the deep muscles and the angles of the ribs.

419. *m. Serratus posticus inferior*, fig. 97, 6, (dorsi-lumbo-costalis,) is broader than the preceding muscle, from which it is separated by a considerable interval, as one of them corresponds with the upper, the other with the lower ribs. It *arises* from the spinous processes and inter-spinous ligaments of the two last dorsal, and two or three upper lumbar vertebræ, by a thin aponeurosis. This ends in a fleshy lamella, which is inserted by four digitations into the bodies of the four last ribs. Its direction is upwards and outwards: structure — partly muscular, partly aponeurotic: relations—its posterior surface is covered by the latissimus dorsi; the anterior rests on the deep lumbar muscles.

420. On the same plane with the serrati, and connecting their borders, may be observed a thin, semi-transparent lamella (*vertebral aponeurosis*), which forms a septum between the third and fourth layer of muscles. Its fibres are for the most part transverse; some, however, take a contrary direction. As the muscles, with their connecting aponeurosis, are stretched from the spinous process to the angles of the ribs, they form with the vertebral grooves a sort of angular canal, in which are lodged the long extensor muscles.

421. The *splenius muscle*, fig. 97, 8, is placed obliquely along the posterior part of the neck; it is usually divided into two parts, one being extended from the spinous processes of the upper dorsal and lower cervical vertebræ, to the side of the base of the skull, the other to the transverse processes of three or four superior cervical vertebræ. This separation of the muscle at its superior attachment has given occasion for its division into two parts, the lower being named splenius colli, the upper splenius capitis.

m. Splenius colli (dorso-trachelius) arises from the spinous processes of four dorsal vertebræ, from the third to the sixth inclusive: the fibres ascend, forming a flat, muscular plane, which is inserted by separate points into the transverse processes of the three or four superior cervical vertebræ, close to the origin of the levator anguli scapulæ.

m. Splenius capitis (cervico-mastoideus) differs from the preceding in situation, being placed superior and internal to it, and is also somewhat broader and thicker. It arises from the spinous processes of the two superior dorsal vertebræ, and of the seventh cervical, also from the ligamentum nuchæ opposite the sixth, fifth, and fourth. From these points its fibres proceed upwards and outwards, to be inserted into the external part of the mastoid process, and also into part of that rough surface on the occipital bone, which is included between its curved lines. Direction—obliquely upwards and outwards; structure—tendinous at its attachments, fleshy in the rest of its extent; relations—its posterior and external surface is covered by the trapezius, sterno-mastoid, and levator anguli scapulæ; the other rests on the complexus, trachelo-mastoid, and longissimus dorsi.

Actions.—The levator anguli scapulæ conspires with the rhomboideus in one of its more obvious actions. When the acromion process is elevated, the posterior angle of the scapula is depressed, and the inferior one carried forwards; but as soon as the more powerful muscles cease to act, the levator draws upwards the posterior angle of the bone, whilst the rhomboid carries backwards and upwards the inferior angle, thus giving a slight rotatory motion to the whole bone, and at the same time depressing the acromion and point of the shoulder. If the shoulder be fixed, the levator may incline the neck down to the same side, just as the trapezius draws the head under the like circumstances. If the rhomboid muscle conspires with the middle and lower part of the trapezius, the base of the scapula will, by their joint effort, be carried directly towards the spine.

The serrati postici, in their action on the thorax (which from their size is necessarily insignificant), are antagonists. The inferior one is enabled by the direction of its fibres to depress the ribs, and to assist in expiration; but the other elevates the ribs, into which it is inserted.

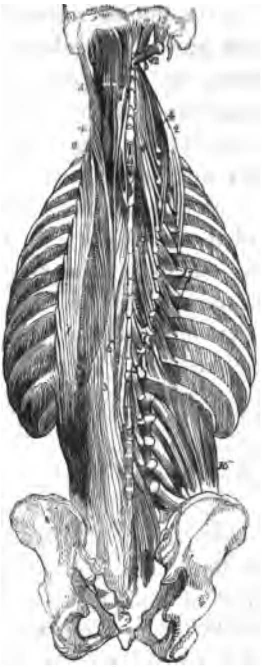
If the splenii muscles of both sides act together, they draw the head directly backwards, in which they conspire with the complexus and trapezius. When those of one side act separately, they incline the head laterally, giving it at the same time a slight rotatory motion. The complexus, too, by reason of the oblique direction of its fibres, can give a certain degree of horizontal motion to the head, but in a direction contrary to that of the splenii, as must be evident from the fact, that the fibres of the one incline outwards as they ascend, and those of the other inwards.

FOURTH LAYER.

422. The term *erector spinæ* may with much propriety be applied to that long, intricate interlacement of muscular fibres, which in the lumbar region forms a thick mass that fills up the vertebral groove, but which along the back becomes divided into two parts, viz. the sacro-lumbalis and longissimus dorsi. The muscle arises, 1, from all the spines of the sacrum, as well as its lateral parts; 2, from the spinous and transverse processes of the four inferior lumbar vertebræ, and the inter-spinous ligaments; 3, from the sacro-iliac ligaments, and from the posterior third of the crista ilii. At its origin from the sacrum, it is tendinous: where it corresponds with the loins, the external half is fleshy, the internal aponeurotic. Opposite the last rib, the muscle becomes separated into the parts above mentioned by a cellular interval.

Dissection.—When you have sufficiently examined the muscles of the third layer, divide the serrati and their aponeurosis in the middle, and reflect the pieces, one inwards, the other outwards. When this is done, the sacro-lumbalis and longissimus dorsi may be traced from below upwards, by merely passing the handle of the scalpel along the cellular interval which separates them. The next step is to detach the splenii at their origin by an incision carried from above downwards close to the spinous processes. These muscles diverge at their upper part, and leave between them an interval in which the complexi are seen. When the splenius has been detached from the vertebræ and reflected outwards, the transversalis colli and trachelo-mastoideus can be followed along the neck, taking them as continuations of the long dorsal muscles. Examine the complexus, then pass the handle of the scalpel under its inner border; draw it outwards so as to get the scalpel deeply under it, and detach it from the transverse processes, cutting from within outwards. Reflect it up to the head, by which means the recti and obliqui capitis are exposed, and also the spinalis colli. Finally, the spinalis dorsi will be observed between the longissimus dorsi and the spinous processes; and when these muscles are removed, that series of oblique muscular and tendinous fibres is exposed which constitutes the multifidus spinæ. When examining the muscles here noticed, you will find not a few variations in their points of attachment in different subjects. I lately saw the trapezius extend only to the seventh dorsal spine; and the deeper seated muscles are much more liable to present changes in the number and extent of the points to which their fibres are fixed.

Fig. 98.



423. *m. Sacro-lumbalis*, fig. 98, 1, or rather (if its attachments be considered) the *sacro-costalis*, proceeds upwards, forming the exterior part of the erector spinæ, inclining a little outwards as it ascends, at the same time becoming narrower, inasmuch as it deposits, as it were, upon each rib part of its fibres. These end in tendinous processes, which are inserted into the angles of the six or seven lower ribs, and so the muscle (at least the part of it that can be traced up from the lumbar region) should be considered as terminating, but that a series of accessory fibres (*m. accessorius ad sacro-lumbalem*) begin to be placed along its inner side, by which it is prolonged to the neck. These bundles of fibres, which are overlapped by the insertions of the muscle itself, commence at the angles of the ribs by tendinous points, which soon become fleshy, and pass up over one or two intercostal spaces, to be inserted successively into the angles of the superior ribs, and into the transverse process of the last cervical vertebra; and so the chain of continuity is maintained along the thorax.

Intimately united with these may be observed another and larger fasciculus of fibres, by which the muscle is prolonged into the neck, and which on that account has been called " cervicalis ascendens," from its resembling a process sent up into the neck from the sacro-lumbalis; whilst others have applied to it the term cervicalis descendens, from the circumstance that its more fixed point of attachment is at the transverse processes of the cervical vertebræ, from which it passes down along the angles of the ribs, and intermingles with the fibres of the sacro-lumbalis. Be this as it may, the cervical prolongation of the sacro-lumbalis, 2, (*m. cervicalis ascendens; cervicalis descendens,*) *arises* from the angles of the sixth, fifth, fourth, and third ribs, by a series of tendinous fasciculi, which are blended with the fibres of the sacro-lumbalis. These gradually unite to form a thin, short, muscular band, which extends along the transverse processes of the sixth, fifth, fourth, and third cervical vertebræ, into which it is inserted by so many separate digitations or points.

424. *m. Longissimus dorsi*, 3, or inner division of the erector spinæ, is prolonged vertically upwards from the lumbar mass, gradually diminishing in size as it ascends. It lies in the middle of the vertebral groove, intermediate between the sacro-lumbalis and the semi-spinalis dorsi, from which it is separated by deep cellular intervals. The posterior surface is smooth and even, but from the anterior a number of processes are sent off, which are inserted into the transverse processes of the dorsal vertebræ, as well as the adjacent rough surface of the ribs. Considerable variety occurs in the number of these attachments to the ribs; sometimes they can be traced to only seven or eight, at others to eleven. The muscle would at first sight appear to cease at the top of the thorax; but when examined in that situation, it will be found connected intimately with two muscular fasciculi, which may be considered as accessories to it. By one of these (the transversalis colli) it is prolonged into the neck, and connected with the transverse processes of the cervical vertebræ; by the other (the trachelo-mastoideus), with the mastoid process and the base of the skull.

425. *m. Transversalis colli*, 4, (transversus cervicis, Sœmm.) *arises* from the transverse processes of the four or five upper dorsal vertebræ, by so many separate points, which are connected with the fibres of the longissimus dorsi: these form a flat, irregular fasciculus, which is prolonged upon the transverse processes of the cervical vertebræ, and inserted by a series of tendinous and fleshy points into their posterior tubercles, from the sixth to the second inclusive. The muscle must, from its mode

of origin and insertion, be thinner towards its extremities than in the middle. Its external side is in contact with the cervicalis ascendens and splenius colli, which rest upon it; the internal one lies on the complexus and trachelo-mastoideus, being, in most instances, so closely united with the latter, that they are with difficulty separated.

426. *m. Trachelo-mastoideus*, 5, is the cranial prolongation of the longissimus dorsi; it is also sometimes called "complexus minor." It arises by a series of distinct fasciculi from the transverse processes of the three or four upper dorsal vertebræ, and the three lower cervical. The union of these forms a flat and thin muscle, which ascends, inclining somewhat outwards, to be inserted into the posterior border and surface of the mastoid process. Its internal surface rests on the complexus for the greater part of its extent; farther up it crosses over the obliquus capitis (superior and inferior), and covers the origin of the digastricus.

427. *m. Spinalis dorsi.* Between the inner border of the longissimus dorsi and the spines of the vertebræ is placed a series of tendinous and fleshy fasciculi, 6, attached by their lower extremities to the first two lumbar and the three contiguous dorsal vertebræ, and by the upper to the eight or nine superior dorsal spines. The fasciculi thus attached at their extremities are free in a great measure towards the middle, and form a separate muscle called spinalis dorsi. The two muscles of this name, when exposed together, represent an elongated ellipse.

428. *m. Complexus*, 7, (trachelo-occipitalis,) is a thick and rather broad muscle, situated somewhat obliquely upon the posterior part of the cervical region. Its name is derived from the peculiar manner in which tendinous and fleshy fibres are intermixed in its structure. It arises from the transverse and articulating processes of the four or five superior dorsal vertebræ, and from the transverse processes of the four inferior cervical, by a series of tendinous points. These are soon aggregated into a mass, which proceeds obliquely upwards and inwards, converging to the corresponding muscle of the opposite side, and finally is inserted into the irregular surface between the curved lines on the occipital bone. At their origin, the two muscles of this name are separated at a considerable interval, but at their insertions they are in close contact. The posterior or external

surface of each, which is inclined obliquely outwards, is in immediate contact superiorly for a short way with the trapezius; in the middle of the neck, the splenius rests upon it, and lower down the trachelo-mastoideus. The anterior, or inner surface rests on the semi-spinalis colli, and higher up on the rectus capitis major, and on the obliqui.

Close by the inner border of the complexus, and in most cases forming a part of it, is a long fasciculus, consisting of two fleshy bellies united by a tendon, and hence named *m. Biventer cervicis.* Inferiorly it presents two or three tendinous and fleshy points attached to as many transverse processes of the dorsal vertebræ from the fourth to the sixth or seventh, and superiorly inserted into the occipital bone near the complexus.

FIFTH LAYER.

429. The *semi-spinalis muscle* is so named from its fibres being placed obliquely between the transverse and spinous processes of the vertebræ. It consists of two parts, one in the cervical, the other in the dorsal region; hence they are described and named as if they were two separate muscles, viz. semi-spinalis colli and semi-spinalis dorsi.

m. Semi-spinalis colli, fig. 98, 8, arises by four or five fasciculi from the transverse processes of the four or five superior dorsal vertebræ. These, having united, incline inwards as they ascend, and are inserted usually by four separate points into the spinous processes of the cervical vertebræ, from the fifth to the second inclusive. Its fibres at their origin are covered by those of the longissimus dorsi, and in the neck by the complexus: its inner surface rests on the termination of the spinalis dorsi, and higher up on the inter-spinales cervicis.

m. Semi-spinalis dorsi, 9, is placed in a continuous line immediately beneath the preceding muscle, and intimately united with it. It arises from the transverse processes of the dorsal vertebræ, from the eleventh to the fifth inclusive, by so many distinct fasciculi. These, having united, pass upwards, and are inserted into the spinous processes of the four superior dorsal and two lower cervical vertebræ. Its fibres, at their origin, are concealed by the longissimus dorsi, and at their insertion, for some way, by the semi-spinalis colli; in the interval they lie between the longissimus dorsi and the spinous processes of the vertebræ.

430. *m. Rectus capitis posticus major*, 10, (axoido-occipitalis,) is situated along the middle line, close to the vertebræ, extending from the spinous process of the axis to the under surface of the base of the skull. It arises by a pointed origin from the process just mentioned, and, gradually enlarging as it ascends, is inserted into the inferior curved line of the occipital bone. It diverges somewhat from the corresponding muscle of the opposite side, and is covered by the complexus.

431. *m. Rectus capitis posticus minor*, 11, (atlo-occipitalis,) extends from the atlas to the base of the skull, being smaller every way than the preceding. It arises from the posterior border of the atlas, and is inserted into the rough surface between the inferior curved line on the occipital bone, and the foramen magnum. It lies nearer to the middle line than the preceding muscle, and can therefore be seen without disturbing it.

432. *m. Obliquus capitis inferior*, 12, (axo-atloideus,) is placed obliquely between the first two cervical vertebræ. It arises from the spinous process of the axis, between the origin of the rectus posticus major and the insertion of the semi-spinalis colli, and is inserted into the extremity of the transverse process of the atlas.

433. *m. Obliquus capitis superior*, 13, (atlo-post-mastoideus,) extends from the atlas to the lateral and inferior part of the base of the skull. It arises from the extremity of the transverse process of the first cervical vertebra, inclines from thence obliquely upwards and inwards, expanding somewhat as it ascends, and is inserted, close behind the mastoid process, into the interval between the curved lines of the occipital bone. These two muscles are covered by the complexus, and correspond, the one with the first inter-vertebral space, the other with that between the atlas and occiput.

434. *m. Inter-spinales*, 14, as their name implies, are short fasciculi of fleshy fibres, placed between the spinous processes of the contiguous pairs of vertebræ. They are well marked and defined in the neck, in the lumbar region they are seldom distinct, and in the dorsal can scarcely be said to exist. As each passes from the upper border of a particular spinous pro-

cess in the neck, to be inserted into that next above it, it must consist of two parts, one for each tubercle, inasmuch as the spinous processes in this region (except the first and last) are bifid at their extremities. Their points of attachment at once indicate their extent and relations.

435. In close contact with the inter-spinales, and placed along their posterior border, may be observed, in most instances, some thin bundles of fibres, which cannot be said to lie within the interval of the spinous processes. On the contrary, they extend from the summit of one to the next, or second next, above it. From this circumstance they have been called *supra-spinales;* and as they increase gradually from below upwards, being situated in the median line, they may be considered as analogous to the recti capitis postici.

When proceeding with the dissection of the muscles here noticed, you will meet with the elevators of the ribs, a series of fleshy and tendinous bundles extended downwards and forwards from the transverse processes of the vertebræ to the margins of the ribs; for these see section 499.

436. *m. Inter-transversales* are placed between the transverse processes of the cervical vertebræ; they can seldom, if ever, be demonstrated in the dorsal or lumbar region. As the transverse processes of the vertebræ in the neck are bifid, the muscles disposed between each pair of them are arranged in two planes, one before the other, so that the cervical nerves, at their exit from the vertebral column, necessarily pass out between them.

437. *m. Multifidus spinæ,* 15, extends along the spinal column from the sacrum to the axis, filling up the deepest part of the groove between the transverse and spinous processes. It is made up of bundles of fleshy and tendinous fibres, intermixed rather confusedly together. The direction of these is more or less oblique, but their length varies considerably, as they are found to reach from the transverse process of a particular vertebra to the spinous process of that immediately above it, and, in other instances, to those higher up by one or two spaces. Thus formed, the structure here described should be considered not as a single muscle, but rather as an aggregate of many, which conspire in their general action on the vertebral column, by reason of the separate influence which each can exert on individual pairs of vertebræ. The first of these

fasciculi extends from the side of the sacrum to the spinous process of the fifth lumbar vertebra, the last from the transverse process of the third cervical vertebra to the spine of the axis. The muscle gradually diminishes in bulk as it ascends; its fibres are intimately blended with those of the semi-spinalis dorsi et colli.

Combined actions.—The sacro-lumbalis, longissimus dorsi, and multifidus spinæ, conspire in fixing the spinal column, and thereby maintaining the trunk erect. If they continue their effort, the body will be drawn somewhat backwards, as may be observed when a considerable weight is suspended from the neck, or in persons who have become excessively fat. In both these cases, the extensor muscles are required to make increased efforts to counterpoise the influence of the weight appended to the fore part of the body. As these muscles have to sustain the trunk in the sitting as well as in the standing posture, it might be supposed that they scarcely admitted of any relaxation, and therefore are kept almost constantly in action. But it does not appear necessary, except in making great efforts, that all of them should be in action at the same moment, and even the different parts of the same muscle must, in most cases, act successively. Thus the lower fibres of the multifidus spinæ pass from the sacrum to the lumbar spines, and materially assist the quadratus lumborum and other muscles in fixing the lumbar vertebræ. These, or rather their transverse processes, become the fixed points from which the succeeding parts of the multifidus act on the spines throughout the entire length of the column, so that a succession of efforts is propagated from below upwards by a sort of vermicular motion. When by such an arrangement the action of one set of fibres succeeds that of another, each will have its alternations of contraction and relaxation, as well as the fibres of those muscles in which the change is more perceptible. The sacro-lumbalis can draw down the lower ribs; and if the effort be continued, this influence must speedily be propagated to the spinal column, which is thus bent towards the side by means of the intimate connexion between the heads of the ribs and the vertebræ. The longissimus dorsi conspires to produce the same effect. The spine admits, to a certain extent, of a rotatory movement. Thus the head may be carried round by a horizontal motion, until the chin comes nearly on a line with the point of the shoulder, after which the spine may be made to turn on its own axis, until the face shall have completed almost a semi-circle, from the point at which its first movement began. The latter movement is effected by that peculiar action of the multifidus spinæ above alluded to; but it is the muscle of the opposite side from that towards which the movement takes place, that produces the rotation, assisted by the obliquus externus abdominis.

The influence of the sacro-lumbalis in depressing the lower ribs must be evident from its mode of attachment to them. But its accessory muscle (cervicalis ascendens), by taking its fixed point at the cervical vertebræ, is enabled to draw up, and therefore elevate, the ribs into which it is inserted.

Muscles of the Upper Extremity.

438. The muscles of the upper extremity, taken in the order of their situation, may be divided into four groups, viz. those placed on the shoulder, those on the arm, on the fore-arm, and on the hand. We must, however, commence the description of the moving powers of the limb with that of the two pectoral muscles and the serratus magnus.

Dissection of the upper arm.—The subject being laid on its back, and the arm drawn away from the side, an incision may be made through the skin, commencing at the middle of the clavicle, and extending down to the centre of the axilla. From this another line may be drawn, downwards and inwards, along the lower border of the pectoralis major. The angular flap thus included should then be raised from off the muscle just named, its dissection being conducted from without inwards to the fore part of the sternum, so as to expose the muscle. It may be necessary to make another incision through the skin, along the clavicle, to the sternum, from the point above indicated. The external flap of the skin may then be dissected off the remainder of the pectoral muscle, and part of the deltoid. When the external surface of the pectoralis major has been examined, it may be detached easily by drawing forwards its lower border, and inserting the scalpel between it and the costal cartilages, and cutting through its attachments to them, as well as to the sternum and clavicle, successively. The muscle may then be drawn outwards, and the fold in its tendon examined. The pectoralis minor is thus exposed, and the axillary vessels partly. The costal attachment of this muscle may be separated in the same way as the other. The axillary vessels are by these measures brought fully into view, little else remaining to be done than to remove the cellular tissue in which they are embedded. For the Axillary Artery,—the Vein,—and the Plexus of Nerves, see subsequent sections.

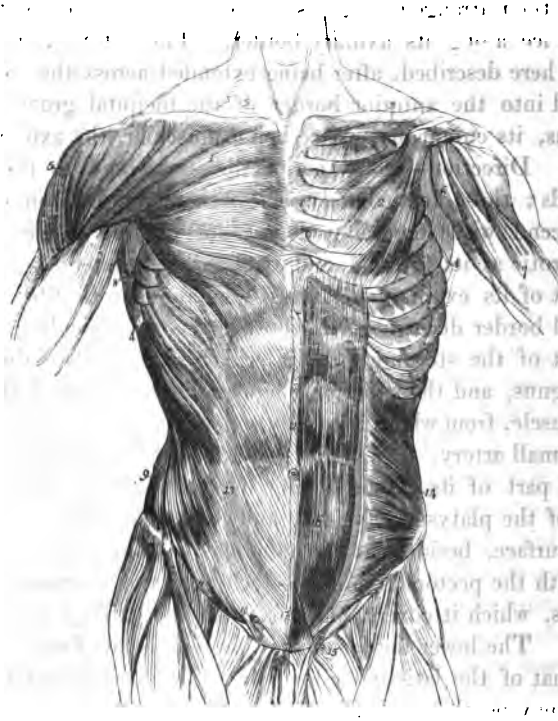
When commencing the dissection of the arm, an incision may be made from the middle of the interval between the folds of the axilla, and thence drawn down to the middle of the space between the condyles of the humerus. This indicates the course of the brachial artery. It should barely divide the skin, care being taken not to injure the fascia beneath it. It will be found convenient to bound it below by a transverse incision; after which, the skin may be cautiously raised from the fascia all round the arm. In order to expose the deltoid, it will be necessary to make an incision through the integument, commencing at the external third of the clavicle, and extended along the acromion and spine of the scapula; after which, it may be dissected off the muscle, proceeding from above downwards and outwards, until the whole flap of skin is removed. When the muscle has been examined, it may be easily detached from its origin, and reflected down on the arm, by inserting the scalpel under its posterior border, and cutting from within outwards, close along the margin of the spine of the scapula, and so successively along the acromion and clavicle. This will expose the circumflex vessels and the external rotator muscles.

The fascia of the arm may in the next place be divided, and reflected in the same way as the integument. In doing so, care should be taken not to injure the internal cutaneous nerve. As the fascia is being reflected, the biceps muscle and the brachial artery and the nerves, except the circumflex and spiral, are brought into view. Their relative position, particularly at the head of the arm, should be attentively considered. If the arm be rotated outward, the direction of the spiral nerve and profunda artery can easily be traced, for some way, between the heads of the triceps muscle. At the outer side of the arm, the nerve will be found in the deep sulcus between the brachialis anticus and supinator longus, after it has made its turn behind the humerus. The external cutaneous nerve also has to reach the external side of the arm, but it runs in front of the humerus, piercing the coracobrachialis muscle, and then lying between the biceps and brachialis anticus. The examination of the triceps had better be conducted from below upwards, following the plan adopted in the description given of it; and when its three heads have been carefully traced out, a longitudinal incision may be made through the substance of the muscle; after which, when the two parts are drawn back, the manner in which the fleshy fibres proceed to the bone, from its tendon or aponeurosis, will be distinctly seen.

THORACIC REGION (ANTERIOR).

439. *m. Pectoralis major*, fig. 99, 1, (sterno-costo-clavi-humeralis,) is placed on the anterior and upper part of the thorax, and in front of the axilla. It is broad and expanded at the former situation, narrowing gradually towards the latter, and *arises* from the sternal half, or a little more, of the clavicle, from the anterior surface of the sternum, extending as far down as the insertion of the cartilage of the sixth rib, and from the cartilages of the true ribs, except the first and last. In some cases, also, a fleshy slip is derived from the aponeurosis of the obliquus externus abdominis, where it covers the rectus muscle. From this extensive origin the fleshy fibres proceed, converging towards the tendon of insertion; those from the clavicle, which are usually separated from the rest by a cellular interval, pass downwards and outwards; those from the lower cartilages obliquely

Fig. 99.



outwards; the middle set horizontally. The muscular fibres become continuous with those of the tendon, and still retain their original direction as they proceed to their respective points of insertion into the humerus; and as the superior fibres descend, whilst the inferior ones ascend, the latter passing behind the former, their arrangement gives to the muscle a folded or twisted appearance along its axillary border. The flat portion of the muscle here described, after being extended across the axilla, is inserted into the anterior border of the bicipital groove in the humerus, its cutaneous surface being muscular, the axillary tendinous. Direction—the superior fibres descend as they pass outwards; those immediately below them are horizontal; the rest ascend with increasing degrees of obliquity: structure—aponeurotic at its internal and external attachments, fleshy in the rest of its extent:—relations—the aponeurotic fibres of its internal border decussate with those of the corresponding muscle in front of the sternum; the inferior border overlaps the serratus magnus, and the superior runs parallel with that of the deltoid muscle, from which it is only separated by the cephalic vein and a small artery. The anterior surface is subcutaneous in the greater part of its extent, being only covered by some of the fibres of the platysma myoides, and by the mamma. The posterior surface, besides the sternum, clavicle, and ribs, is in relation with the pectoralis minor, subclavius, and serratus magnus muscles, which it covers, and also with the axillary vessels and nerves. The lower border of this muscle is at first separated from that of the latissimus dorsi by a considerable interval, in which may be observed the fibres of the serratus magnus; but they gradually converge towards the axilla, forming its folds or borders.

440. *m. Pectoralis minor*, fig. 99, 2, (costo-coracoideus,) lies at the superior part of the thorax, covered by the preceding muscle, and extended obliquely across the axilla. It *arises* from the external surface of the third, fourth, and fifth ribs, near their cartilages; its margin being usually dentated, so that some of the older anatomists named it "serratus anticus minor." The fleshy fibres, as they proceed obliquely upwards and outwards, converge to a narrow tendon, which is inserted into the inner and upper border of the coracoid process near its extremity. Its direction and structure have been here sufficiently indicated.

Relations—the anterior surface is covered by the pectoralis major, the posterior crosses the axillary vessels and nerves.

441. m. *Subclavius*, fig. 99, 3, (costo-clavicularis,) is placed under the clavicle, in the interval between it and the first rib. It *arises* by a small short tendon from the cartilage of the first rib, close to the rhomboid ligament, from which it is directed outwards beneath the clavicle, forming a rounded fleshy fasciculus, which is inserted into the grooved and rough surface, along the costal aspect of the clavicle, for nearly half its length. Relations—its upper surface is covered by the clavicle, a small part beneath it being overlapped by the pectoralis major, but which is at first not perceptible, until a dense fascia that covers it is dissected off; the costal surface lies in front of the subclavian vessels as they pass down from the neck.

THORACIC REGION (LATERAL).

442. m. *Serratus magnus*, fig. 99, 4, (costo-basi-scapularis,) is placed upon the upper and lateral parts of the thorax, between the ribs and the scapula, being deeply seated in the greater part of its extent. Its anterior border presents eight or nine fleshy points or digitations, giving it a serrated appearance, whence its name is taken. By these, as its points of attachment, it *arises* from the surface of the eight superior ribs; for it is generally found that two of the processes come from the second rib, or, at all events, the one arising from it is larger than any of the others, and not unfrequently of a deeper colour. From this extensive origin, the fibres of the muscle, forming a flat thin plane, converge as they proceed backwards, and are inserted into the base of the scapula, being interposed between the subscapularis on the one side, and the rhomboidei and levator anguli scapulæ on the other. Structure—fleshy in its entire extent. If the muscle be put on the stretch by drawing the scapula backwards, its fibres will be observed to be arranged in flat fasciculi, traceable from its serrated border, and distinguished from one another by deep linear impressions. Relations—one surface rests on the superior ribs, the intercostal muscles, and part of the serratus posticus superior; the other is subcutaneous in the angular interval between the pectoralis and latissimus dorsi; higher up it is covered by both the pectoral muscles; in the rest of its extent it is in relation with the subscapular muscle

and the axillary vessels. The greater number of its fibres will be observed to converge towards the angles of the scapula, particularly the lower one.

Combined actions.—The most obvious actions of these muscles are exerted upon the shoulder and arm, as being their more movable points of attachment. The pectoralis major, conjointly with the latissimus dorsi and teres major, depresses the humerus, if it has been previously elevated; it then conspires with them in pressing the arm closely to the side, and, continuing the same effort, will by itself trail it along the side and front of the chest. The pectoralis minor draws the point of the shoulder downwards and inwards to the thorax. If the arms be fixed, these muscles act on the ribs and assist in dilating the chest. This is frequently observed during the forcible efforts at inspiration made by asthmatic persons; the arms are rendered fixed, by seizing hold of some object, and then every muscular effort is called into play which can elevate the ribs.

When the scapula is rendered fixed by the trapezius and rhomboid muscles, the serratus acts on the chest in the same way as the pectoral muscles do; but its most ordinary action is to draw the base and inferior angle of the scapula forwards, so as to elevate the point of the shoulder by means of the rotatory motion it can impress upon it conjointly with the trapezius, as has been observed when treating of the latter muscle. The continuation of the same effort retains the shoulder elevated, as when a burden is sustained upon it; but, as a preparatory measure, the thorax must be fixed. Whilst any important muscular exertion is being performed, the thorax must be fixed, and retained so by preventing the escape of the included air. This may be inferred from observation on what takes place under such circumstances, but was reduced to the test of experiment by M. Bourdon.* He opened the trachea, or larynx, of a dog that had been in the habit of jumping and tumbling when bidden; after which, the animal was no longer able to make any similar efforts, though evidently willing to do so. But when the aperture was closed, by drawing the margins of the wound together, the lost power was instantly restored.

ACROMIAL REGION.

443. *m. Deltoideus*, fig. 99, 5, (sub-acromio-humeralis,) is situated at the superior and external part of the arm, covering in

* Mémoire sur les Efforts.

the shoulder-joint; its form is triangular, the base above, and the apex below. It *arises* from the external third of the clavicle, from the lower border of the acromion, and from the spine of the scapula, as far back as the small triangular surface in which it terminates; and is inserted into the rough prominence on the middle of the outer side of the humerus. Direction—the middle fibres descend perpendicularly, the anterior and posterior converge to these as to a common point: structure—fleshy and tendinous at its base, tendinous at its apex, fleshy in the rest of its extent: relations—by the outer surface, with the platysma myoides and integuments; by the inner surface, with the tendon of the pectoralis major, the circumflex vessels and nerves, the outer side of the humerus, the fibrous capsule of the shoulder-joint, the coracoid process, the pectoralis minor, coraco-brachialis, biceps, subscapularis, coraco-acromion ligament, the external rotator muscles, and the triceps; by the anterior border, with the pectoralis major (from which it is separated by the cephalic vein), and more inferiorly with the biceps: the posterior border is free.

SCAPULAR REGION (POSTERIOR).

444. *m. Supra-spinatus*, fig. 97, 4, is placed at the superior part of the shoulder, in the supra-spinous fossa of the scapula. Its form is elongated and triangular. It *arises* from the posterior two-thirds of the fossa above mentioned, and is inserted into the superior surface of the greater tuberosity of the humerus. Direction—oblique from behind forwards: structure—tendinous at the humeral end, fleshy in the rest of its extent: relations—by the outer surface, with the trapezius, coraco-acromion ligament, and deltoid; by the inner surface, with the scapula and the ligamentum proprium posticum, with the supra-scapular nerve and vessels, the omo-hyoideus muscle, and the fibrous capsule of the shoulder-joint, with which it is intimately united.

445. *m. Infra-spinatus*, fig. 97, 5, occupies the chief part of the infra-spinous fossa, and *arises* from the lower surface of the spine of the scapula, and from all the convex part of its dorsum. The fibres converge to a tendon, at first concealed in a great degree within the substance of the muscle, but which afterwards proceeds forwards over the capsular ligament of the joint, to be inserted into the upper border of the great tuberosity of the

humerus. Direction—from behind forwards, the superior fibres being nearly horizontal, the inferior ones converging to meet them: structure—tendinous at the humeral end, and for some way along its centre, fleshy in the rest of its extent: relations—the posterior surface is covered, partly by the deltoid, the latissimus dorsi, and trapezius, a small part also being subcutaneous; the anterior rests on the bone and capsular ligament. The lower border is in contact with the teres minor, being united posteriorly with it and the teres minor.

446. *m. Teres minor*, fig. 97, 6, lies along the inferior border of the scapula; its form is elongated, narrow, and round. It *arises* by a series of oblique fibres from the dorsal surface of that ridge which surmounts the axillary border of the scapula, and from two aponeurotic septa, placed between it and the infra-spinatus and teres major muscles. Its insertion lies immediately below that of the infra-spinatus, into the greater tuberosity of the humerus. Direction—oblique from behind forwards and upwards: structure—tendinous at its humeral end, fleshy in the rest of its extent: relations—by the outer surface with the integuments and deltoid muscles; by the inner with the scapula, the posterior or dorsal branch of the sub-scapular artery, the long head of the triceps muscle, and the fibrous capsule of the shoulder-joint. The upper border lies in contact with the infra-spinatus; the lower with the teres major, but is separated anteriorly from it by the long head of the triceps; the posterior extremity is, as it were, inserted between the teres major and infra-spinatus, being connected with both, as has been above stated.

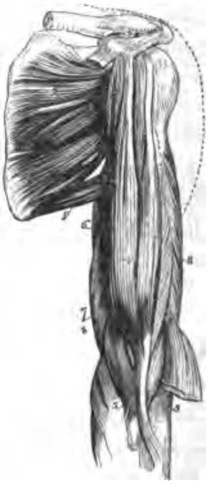
The three flat surfaces marked on the upper border of the great tuberosity of the humerus give insertion to these three muscles, taken in their regular order, from above downwards.

447. *m. Teres major*, fig. 100, 1, extends from the inferior angle of the scapula to the humerus, contributing to form the posterior border of the axilla. It is rather broad and compressed than round, as its name would imply. It *arises* from the flat expanded surface placed at the inferior angle of the scapula, and from the septa interposed between it and the teres minor and infra-spinatus. Its insertion takes place by a broad flat tendon into the posterior border of the bicipital groove in the humerus, being in close contact with the tendon of the latissimus

dorsi. Its direction must necessarily vary according to the different positions of the scapula and humerus. Towards their insertion its fibres appear to descend somewhat, whilst those of the latissimus ascend, so that its border is placed lower down than that of the latter muscle. Structure — tendinous at its insertion, fleshy in the rest of its extent: relations — its posterior surface is covered by the latissimus dorsi and integument, and crossed by the long head of the triceps; the anterior, in part of its extent, is in contact with the latissimus (in consequence of the change of direction of the latter), and slightly with the coraco-brachialis and brachial vessels.

SCAPULAR REGION (ANTERIOR).

Fig. 100.



448. *m. Sub-scapularis*, fig. 100, 2, fills up the hollow of the scapula, lying between that bone and the thorax, from which, however, it is separated by the serratus magnus muscle. It *arises* from the entire surface of the sub-scapular fossa, its fibres being divided into two or three bundles by aponeuroses connected with the prominent lines marked on the bone. From this extensive origin the fibres converge to a thick tendon, which, after being intimately united with the capsular ligament, is inserted into the lesser tuberosity of the humerus. Direction—from behind forwards, the superior fibres being nearly horizontal, the inferior ascending obliquely: structure—tendinous at its humeral extremity, fleshy in the rest of its extent: relations—by the outer, or posterior surface, with the scapula, and the fibrous capsule of the shoulder, to which it is intimately adherent; by the inner, or anterior surface, with some loose cellular tissue separating it from the serratus magnus, and the brachial plexus of nerves.

Actions.—The deltoid can raise the arm directly from the side, so as to bring it at right angles with the body; after which, by means of its anterior and posterior fibres, it can carry the limb alternately backwards and forwards, being assisted in the former movement by the teres major and latissimus dorsi, in the latter by the pectoralis major. The mass of its muscular fibres is so considerable, that it is enabled, by pressing down the head of the humerus, to make it glide upon the surface of the glenoid cavity of the scapula, and then, by continuing the effort, to raise the limb directly upwards, so as to bring it to the vertical position. Its only assistant in elevating the arm is the supra-spinatus, (whose power in this respect must be trivial, as it is inserted so near the centre of motion).

The supra-spinatus, infra-spinatus, and teres minor, are the external rotators of the arm, whilst the sub-scapularis rotates it inwards; for, as they are opposed in situation, so they are antagonists in action. The power of these muscles is increased in no small degree by passing over the globular head of the humerus, and also by being inserted into the prominent processes of bone which remove the line of their direction to a distance from the axis of the humerus. The teres major conspires with the latissimus dorsi in its actions; it depresses the arm, if raised, and rotates it on its axis. If the arm be fixed, as when, in the reclining posture, the elbow is removed from the side, these muscles, particularly the teres major, assisted by the long head of the triceps, can approximate the lower border of the scapula to the shaft of the humerus, thus conspiring with other muscles, viz. the pectoralis and latissimus dorsi, to trail the body after the out-stretched limb.

HUMERAL REGION (ANTERIOR).

449. *m. Coraco-brachialis*, fig. 100, 3, is placed along the superior and inner part of the arm for about half its length. It *arises* from the coracoid process of the scapula, between the pectoralis minor and the short head of the biceps, also from the tendon of the latter, with which it is intimately united for some way. The fleshy fasciculus thus formed passes downwards and a little outwards, to be inserted into the inner side of the humerus about its middle, where it is interposed between the brachialis anticus and the triceps. Direction—nearly vertical: structure—aponeurotic at its attachments, fleshy in the middle: relations—its anterior surface is covered above by the deltoid and pectoralis major, and at its insertion is crossed by the brachial artery. The posterior surface runs over the tendon of the sub-scapularis, and those of the latissimus dorsi and teres

major, the axillary vessels intervening; one border is in apposition with the biceps, the other with the brachial artery; its belly is usually pierced by the external cutaneous nerve.

450. *m. Biceps flexor cubiti*, fig. 100, 4, (coraco-scapulo-radialis,) lies along the anterior part of the arm for its entire length. Superiorly it is divided into two heads, whence its name is derived. Of these, the *internal* or short *head*, *arises*, conjointly with the coraco-brachialis, from the extremity of the coracoid process, from which it descends, and unites at an acute angle with the *external* or long head, which *arises* from the upper border of the glenoid cavity, where it is also connected with the fibrous rim which surrounds that cavity. The tendon passes over the globular head of the humerus, enclosed in a sheath formed by the synovial membrane of the joint, and, after piercing the fibrous capsule, and descending some way in the groove appropriated for it, unites, as above stated, with the short head. The long, rounded, fleshy belly thus formed ends near the bend of the arm, in a flat tendon, which sinks deeply between the muscles of the fore-arm, and is inserted into the posterior part of the tubercle of the radius. Direction—vertical: structure—tendinous at its extremities, fleshy in all the rest of its extent. From the tendon of insertion a fibrous expansion, presenting an arched border, is sent off, as it is about to sink between the muscles of the fore-arm. This process passes obliquely downwards and inwards, and becomes blended with the fascia of the fore-arm somewhat below the inner condyle; it is stretched across the brachial artery, median nerve, and part of the pronator teres muscle. Relations—the anterior surface is overlapped superiorly for some way by the deltoid and pectoral muscles; but in all the rest of its extent it is subcutaneous. The posterior surface, for about half its length, rests on the humerus and shoulder-joint, and in the rest on the brachialis anticus, being separated from the latter by the external cutaneous nerve. The inner border is in contact with the coraco-brachialis for half its length, and with the brachial artery for the rest.

451. *m. Brachialis anticus*, (humero-cubitalis,) fig. 100, 5, lies under cover of the biceps, along the lower half of the arm. It is somewhat compressed in its form, and broader in the

middle than at the extremities. It *arises* from the fore-part of the humerus, commencing at the insertion of the deltoid, which it embraces by two angular fleshy processes, and extending nearly to the border of the trochlea. Some fibres also arise from the inter-muscular septa at each side. These, after passing in front of the elbow-joint, end in a thick fasciculus of tendinous fibres, which is inserted into the rough surface on the fore-part of the coronoid process of the ulna. Direction—the middle fibres are vertical, those on each side converge a little to them: structure—tendinous at its insertion, fleshy in the rest of its extent: relations—the posterior surface rests on the bone and capsular ligament; the anterior, partly concealed by the biceps, projects somewhat at each side of it, and supports the brachial artery and median nerve.

Combined Actions.—The most obvious action of the biceps is that of flexing the fore-arm, in which it conspires with the brachialis anticus; it also serves to render tense the fascia of the arm by means of the process which connects its tendon with that membrane. If the arm be placed in the prone position, the biceps can turn it supine, being in this particular the direct antagonist of the pronator radii teres. When the fore-arm is rendered fixed by holding some firm object, the biceps and brachialis muscles can draw on the humerus, and bend it forwards on the arm, which is exemplified in the effort of climbing. They also can move the humerus on the scapula; but their influence in this respect must be very limited, as they run parallel with the axis of the bone. When the humerus is fixed, these muscles, by drawing on the coracoid process, move the scapula, and therefore the glenoid cavity on the head of the bone, so that the latter may receive support from the former, rather than that it should be pressed up against the capsular ligament solely.

HUMERAL REGION (POSTERIOR).

452. *m. Triceps extensor cubiti* rests against the posterior surface of the humerus in its entire length, being the only muscle that lies behind the bone and inter-muscular septa. Superiorly it is divided into three processes or heads, whence its name is derived, whilst its lower half, or more, remains single and undivided. In order to facilitate its description, we shall adopt Bichât's plan, and commence at the lower extremity of

ment is effected by that peculiar action of the multifidus spinæ above alluded to; but it is the muscle of the opposite side from that towards which the movement takes place, that produces the rotation, assisted by the obliquus externus abdominis.

The influence of the sacro-lumbalis in depressing the lower ribs must be evident from its mode of attachment to them. But its accessory muscle (cervicalis ascendens), by taking its fixed point at the cervical vertebræ, is enabled to draw up, and therefore elevate, the ribs into which it is inserted.

Muscles of the Upper Extremity.

438. The muscles of the upper extremity, taken in the order of their situation, may be divided into four groups, viz. those placed on the shoulder, those on the arm, on the fore-arm, and on the hand. We must, however, commence the description of the moving powers of the limb with that of the two pectoral muscles and the serratus magnus.

Dissection of the upper arm.—The subject being laid on its back, and the arm drawn away from the side, an incision may be made through the skin, commencing at the middle of the clavicle, and extending down to the centre of the axilla. From this another line may be drawn, downwards and inwards, along the lower border of the pectoralis major. The angular flap thus included should then be raised from off the muscle just named, its dissection being conducted from without inwards to the fore part of the sternum, so as to expose the muscle. It may be necessary to make another incision through the skin, along the clavicle, to the sternum, from the point above indicated. The external flap of the skin may then be dissected off the remainder of the pectoral muscle, and part of the deltoid. When the external surface of the pectoralis major has been examined, it may be detached easily by drawing forwards its lower border, and inserting the scalpel between it and the costal cartilages, and cutting through its attachments to them, as well as to the sternum and clavicle, successively. The muscle may then be drawn outwards, and the fold in its tendon examined. The pectoralis minor is thus exposed, and the axillary vessels partly. The costal attachment of this muscle may be separated in the same way as the other. The axillary vessels are by these measures brought fully into view, little else remaining to be done than to remove the cellular tissue in which they are embedded. For the Axillary Artery,—the Vein,—and the Plexus of Nerves, see subsequent sections.

When commencing the dissection of the arm, an incision may be made from the middle of the interval between the folds of the axilla, and thence drawn down to the middle of the space between the condyles of the humerus. This indicates the course of the brachial artery. It should barely divide the skin, care being taken not to injure the fascia beneath it. It will be found convenient to bound it below by a transverse incision; after which, the skin may be cautiously raised from the fascia all round the arm. In order to expose the deltoid, it will be necessary to make an incision through the integument, commencing at the external third of the clavicle, and extended along the acromion and spine of the scapula; after which, it may be dissected off the muscle, proceeding from above downwards and outwards, until the whole flap of skin is removed. When the muscle has been examined, it may be easily detached from its origin, and reflected down on the arm, by inserting the scalpel under its posterior border, and cutting from within outwards, close along the margin of the spine of the scapula, and so successively along the acromion and clavicle. This will expose the circumflex vessels and the external rotator muscles.

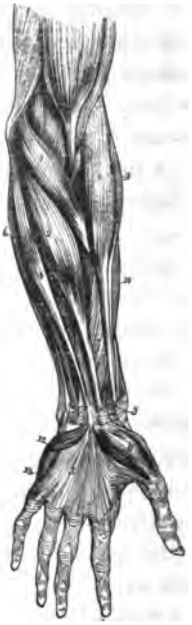
The fascia of the arm may in the next place be divided, and reflected in the same way as the integument. In doing so, care should be taken not to injure the internal cutaneous nerve. As the fascia is being reflected, the biceps muscle and the brachial artery and the nerves, except the circumflex and spiral, are brought into view. Their relative position, particularly at the head of the arm, should be attentively considered. If the arm be rotated outward, the direction of the spiral nerve and profunda artery can easily be traced, for some way, between the heads of the triceps muscle. At the outer side of the arm, the nerve will be found in the deep sulcus between the brachialis anticus and supinator longus, after it has made its turn behind the humerus. The external cutaneous nerve also has to reach the external side of the arm, but it runs in front of the humerus, piercing the coracobrachialis muscle, and then lying between the biceps and brachialis anticus. The examination of the triceps had better be conducted from below upwards, following the plan adopted in the description given of it; and when its three heads have been carefully traced out, a longitudinal incision may be made through the substance of the muscle; after which, when the two parts are drawn back, the manner in which the fleshy fibres proceed to the bone, from its tendon or aponeurosis, will be distinctly seen.

they are described, commencing with those attached to the inner condyle.

The *superficial* muscles of the anterior and inner part of the fore-arm are, the pronator radii teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor digitorum sublimis. These are all intimately united at their origin from the *inner condyle*, to which they are attached by a *common tendon* that gives a fasciculus of fibres to each, and also sends septa between them.

455. *m. Pronator radii teres*, fig. 102, 1, is extended obliquely across the front of the arm at its upper third. It *arises* by two distinct heads; one, large and superficial, is derived from the common tendon, from the fascia of the fore-arm, and the septum between this muscle and the flexor carpi radialis; the other head is a thin fasciculus which lies deeply (coming from the margin of the coronoid process), and joins the other at an acute angle, being previously separated from it by the median nerve. The fleshy belly thus formed proceeds outwards and downwards, to be inserted tendinous into the outer border of the radius about its middle. Direction — oblique from above, downwards and outwards: structure—tendinous and fleshy: relations—its anterior surface is superficial in the greater part of its extent; but towards its insertion it is crossed by the radial artery and nerve, and the supinator longus muscle. Its ulnar border is in contact with the flexor carpi radialis and palmaris longus: the radial border bounds, with the supinator longus, an angular space, in which are placed the brachial artery, the median nerve, and the tendon of the biceps muscle.

Fig. 102.



456. *m. Flexor carpi radialis*, fig. 102, 2, is situated in front of the fore-arm, being extended from the inner condyle towards the root of the thumb. It *arises* from the inner condyle by

outwards; the middle set horizontally. The muscular fibres become continuous with those of the tendon, and still retain their original direction as they proceed to their respective points of insertion into the humerus; and as the superior fibres descend, whilst the inferior ones ascend, the latter passing behind the former, their arrangement gives to the muscle a folded or twisted appearance along its axillary border. The flat portion of the muscle here described, after being extended across the axilla, is inserted into the anterior border of the bicipital groove in the humerus, its cutaneous surface being muscular, the axillary tendinous. Direction—the superior fibres descend as they pass outwards; those immediately below them are horizontal; the rest ascend with increasing degrees of obliquity: structure—aponeurotic at its internal and external attachments, fleshy in the rest of its extent:—relations—the aponeurotic fibres of its internal border decussate with those of the corresponding muscle in front of the sternum; the inferior border overlaps the serratus magnus, and the superior runs parallel with that of the deltoid muscle, from which it is only separated by the cephalic vein and a small artery. The anterior surface is subcutaneous in the greater part of its extent, being only covered by some of the fibres of the platysma myoides, and by the mamma. The posterior surface, besides the sternum, clavicle, and ribs, is in relation with the pectoralis minor, subclavius, and serratus magnus muscles, which it covers, and also with the axillary vessels and nerves. The lower border of this muscle is at first separated from that of the latissimus dorsi by a considerable interval, in which may be observed the fibres of the serratus magnus; but they gradually converge towards the axilla, forming its folds or borders.

440. *m. Pectoralis minor*, fig. 99, 2, (costo-coracoideus,) lies at the superior part of the thorax, covered by the preceding muscle, and extended obliquely across the axilla. It *arises* from the external surface of the third, fourth, and fifth ribs, near their cartilages; its margin being usually dentated, so that some of the older anatomists named it "serratus anticus minor." The fleshy fibres, as they proceed obliquely upwards and outwards, converge to a narrow tendon, which is inserted into the inner and upper border of the coracoid process near its extremity. Its direction and structure have been here sufficiently indicated.

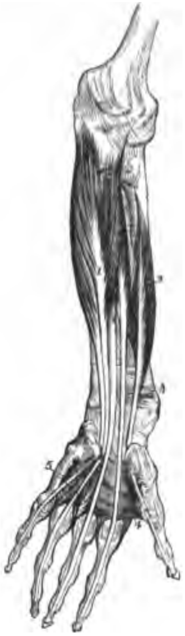
coronoid process, and from the oblique line extended from the tubercle of the radius to the insertion of the pronator teres. The fleshy belly enlarges towards the middle of the arm, but diminishes somewhat before its division. The four tendons pass under the annular ligament of the wrist, resting on the flexor profundus; and diverge as they proceed to their destinations. Each of these, accompanied by a tendon from the flexor profundus, enters a fibrous sheath that binds it down to the palmar surface of the finger, and opposite the first phalanx it presents a fissured interval, which transmits the tendon of the deep flexor. Finally, after expanding somewhat, and forming a groove, by its palmar surface, which partly encloses the accompanying tendon, it is inserted into the fore part of the second phalanx. The same arrangement obtains in each instance. The direction and structure of the muscle have been here sufficiently indicated. Relations — superiorly concealed by the other muscles of this set, it rests on the flexor pollicis longus and flexor profundus, separated from the latter by the median nerve. In the palm of the hand, its tendons are covered by the palmar fascia, the superficial palmar arch of arteries, and the branches of the median nerve. Where the tendons slide beneath the annular ligament, they are invested by a synovial membrane, to facilitate their movements.

The *deep-seated* muscles, on the anterior surface of the fore-arm, are the flexor profundus, flexor pollicis longus, and pronator quadratus.

Dissection.—When the superficial muscles have been examined, consisting of the pronator teres, flexor radialis, pulmaris longus, flexor ulnaris, and flexor sublimis, their common origin may be divided, and the whole mass drawn down towards the hand, which will expose the flexor profundus and flexor pollicis longus, as well as the median nerve and ulnar artery. The inter-osseous nerve and artery will at once be found between the two muscles last mentioned.

460. *m. Flexor digitorum profundus vel perforans*, fig. 103, 1, lies deeply along the ulnar border of the fore-arm, covered by the preceding muscles. It is compressed above, presents in the middle a fleshy belly of considerable size, and inferiorly is divided into four tendons. The muscle *arises* from the hollow at the inner side of the olecranon,—from the inner border and

Fig. 103.



anterior surface of the ulna, to within a few lines of the edge of the pronator quadratus, and from the ulnar half of the inter-osseous ligament. The four tendons, by which the muscle is continued into the palm, pass beneath the annular ligament, interposed between those of the flexor sublimis and the carpal bones, and maintain the same relation to the latter as they pass along the metacarpal bones and digital phalanges. Opposite the first phalanx of each finger, its tendon passes through the fissure formed for its transmission in the tendon of the flexor sublimis, and proceeds (still bound down by fibrous sheath) to be inserted into the base of the last phalanx. It is unnecessary to add anything more as to its direction or structure. Relations—its upper extremity in a manner embraces the insertion of the brachialis anticus; the posterior surface rests on the ulna, inter-osseous ligament, and pronator quadratus; the anterior is covered by the ulnar artery and nerve, the median nerve, and the other flexor muscles. The external border is parallel with the flexor pollicis longus, from which it is separated by the anterior inter-osseous artery.

461. *m. Flexor pollicis longus*, fig. 103, 2, lies on the same plane as the flexor profundus, resting on the radius. It *arises* from the grooved surface on the fore part of the radius, commencing just below the oblique line which extends from its tubercle to the insertion of the pronator teres, and reaching nearly to the edge of the pronator quadratus, also from the adjacent part of the inter-osseous ligament. The fleshy fibres come forward to a tendon, which, after passing beneath the annular ligament of the wrist, turns outwards, lying between the two heads of the flexor brevis and the sesamoid bones, then enters a fibrous sheath similar to those for the other flexor tendons, and finally becomes inserted into the base of the second phalanx of the thumb. Relations—its anterior surface is

covered by the flexor carpi radialis, flexor sublimis, and somewhat by the pronator teres, also by the radial vessels. Towards the lower part of the arm, its fibres can be readily perceived between the tendon of the supinator longus and flexor carpi radialis.

462. *m. Pronator quadratus*, fig. 103, 3; fig. 107, 1, is extended across the radius and ulna, immediately above their carpal extremity; it is flat and thin, and about two inches in breadth. Its origin, or fixed attachment, is from the inner border of the ulna, in the situation and extent just mentioned. The fibres pass directly across, to be inserted into the fore part and anterior surface of the radius. Its structure is fleshy; one surface rests on the bones and inter-osseous ligament, the other is covered by the muscles and vessels that pass into the palm of the hand.

Combined Actions.—These muscles act on the fore-arm, the hand, and the digital phalanges. The radius is made to turn on the ulna, and the hand thereby pronated by the pronator teres and quadratus, which take their fixed points, the one on the humerus, the other on the ulna, and draw the radius inwards across the latter bone. Should the pronator teres, after having effected so much, continue its action, it becomes virtually a flexor, and will assist the other muscles in bending the fore-arm on the arm. So also the flexors of the fingers, after having bent the phalanges towards the palm, begin to act on the wrist, and then contribute to the flexion of the fore-arm by means of the mechanical advantage they derive by passing under the annular ligament of the wrist. The flexores carpi, too, after having bent the wrist, become subsequently flexors of the fore-arm. The flexion of the phalanges is obviously effected by the superficial and deep common flexors, and by the flexor pollicis.

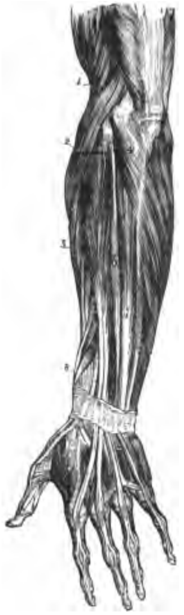
RADIAL REGION.

The muscles placed along the outer side of the fore-arm are the supinator radii longus and brevis, the extensor carpi radialis longior and brevior.

Dissection.—These muscles are readily exposed by reflecting the skin and the fascia outwards from a few inches above the external condyle down to the wrist; the preceding dissections obviously mark out the way of conducting this.

463. *m. Supinator radii longus*, fig. 102, 8; fig. 104, 1, is the most prominent muscle of this set, and lies upon the radial border of the arm, extended from nearly the middle of the humerus to the end of the radius. It *arises* from the external condyloid ridge of the humerus, nearly as high up as the insertion of the deltoid, where it is interposed between the brachialis anticus and the external inter-muscular septum, to which also its fibres are attached. The rounded, fleshy belly, thus formed, descends upon the anterior and outer border of the arm, and, about its middle, ends in a flat tendon, which, continuing the same course, is inserted into the external border of the radius, close to the base of its styloid process. This muscle is covered only by the skin and fascia; it rests on the humerus, extensor carpi radialis (longior and brevior), the insertion of the pronator teres, and the supinator radii brevis. The inner border is in contact, above the bend of the elbow, with the brachialis anticus, from which it is separated by the spiral nerve and the accompanying artery; along the arm it is in contact with the radial artery and nerve.

Fig. 104.



464. *m. Extensor carpi radialis longior*, fig. 102, 9; fig. 104, 2, is partly covered by the preceding muscle, but its external border projects beyond it. It *arises* lower down than the supinator longus, from the external condyloid ridge as well as from the inter-muscular septum. After passing along the outside of the articulation, it ends, at the upper third of the arm, in rather a broad, flat tendon, which descends along the outer and back part of the radius; passes, conjointly with the following muscle, in a groove in the lower extremity of that bone; and is inserted into the base of the metacarpal bone of the fore-finger. The fleshy part of the muscle lies between the supinator longus and extensor carpi radialis brevior, but is concealed only in part by them; its tendon passes beneath the

extensors of the thumb, and the posterior annular ligament of the wrist.

465. *m. Extensor carpi radialis brevior*, fig. 102, 10; fig. 104, 3, lies along the posterior and external aspect of the radius. It *arises* from the extremity of the outer condyle of the humerus, and from the external lateral ligament of the elbow-joint. The fleshy belly, lying behind the preceding muscle, ends in a flat tendon, which remains closely applied to that of the latter, and with it proceeds in the groove in the radius, and under the annular ligament, where it diverges somewhat, in order to be inserted into the base of the metacarpal bone of the middle finger.

Combined Actions.—These are the direct antagonists of the pronators of the hand and flexors of the wrist. If the hand be previously pronated, the supinators, by rolling the radius on the ulna, turn the palm supine; but the extent and power of action of each differ considerably. The supinator longus, notwithstanding its length and size, can act but feebly in supinating the hand, inasmuch as its direction is parallel with that of the radius; its direction and attachments indicate it to be a flexor of the fore-arm. The supinator brevis (sect. 474), both by its direction and mode of attachment, is by far the more efficient agent in moving the radius on the ulna. The action of the radial extensors is fully indicated by their name; if their effort be continued, they assist in extending the fore-arm on the arm.

BRACHIAL REGION (POSTERIOR AND SUPERFICIAL).

The muscles situated on the posterior aspect of the fore-arm are the anconeus, the extensor communis digitorum, extensor carpi ulnaris, and extensor minimi digiti, which are superficial; whilst the rest are deep-seated, viz. the three extensors of the thumb, the extensor indicis, and the supinator radii brevis.

Dissection.—The muscles on the posterior side of the fore-arm are numerous, and closely connected together, so that their dissection and arrangement are sometimes deemed difficult. An incision may, in the first place, be made from the olecranon to the middle of the back of the hand, which should be bounded at each extremity by a transverse incision. The skin having been thus divided, may be reflected off the fascia in its entire extent; and when the fascia has been examined, it may be divided in the same way as the skin, and dissected off the muscles, which will be facilitated by proceeding from below upwards, taking the different tendons as guides to their respective muscles, until all of them are exposed, and their borders defined. When this has been effected, little difficulty will be experienced in distinguishing them from one another, if the first line of the description given of them be attended to, as it indicates the situation and direction of each; and when the name of a muscle is known, everything relative to its anatomical characters will be found in the section which treats of it.

466. *m. Anconeus*, fig. 104, 4, is placed immediately behind and beneath the elbow-joint, being a small triangular muscle. It *arises*, by a tendinous and fleshy point, from the extremity of the outer condyle of the humerus, at its posterior aspect. From this the fibres proceed, diverging from one another, the upper ones being horizontal, the rest passing with increasing degrees of obliquity; but all are inserted into the radial aspect of the olecranon and the adjacent border of the ulna itself. It is superficial in its entire extent, and lies below the triceps extensor, with which it conspires in its action.

467. *m. Extensor communis digitorum*, fig. 104, 5, lies along the posterior part of the fore-arm. It *arises* by a tendon common to it, the extensor carpi ulnaris, and extensor carpi radialis brevior, also from the fascia of the arm, and the septa between it and the last-named muscles. Somewhat below the middle of the fore-arm the muscular part ends in four tendons, which, after passing beneath the posterior annular ligament of the wrist, diverge as they proceed along the carpus and metacarpus. Each of these expands on reaching the fingers, forming a fibrous sheath, which encases the back of the first and second digital phalanges, and terminates upon the third, into which they are thus inserted. Opposite the second joint, the tendon appears to divide into two fasciculi, which leave an elliptic interval between them, into which the knuckle may protrude when the finger is bent. The tendon, however, is not deficient at this part; it is much thinner than at the sides, and the thin part is inserted into the base of the second phalanx. The same arrangement obtains at the third joint. At its origin this muscle lies between the extensor carpi radialis brevior and extensor carpi ulnaris, and maintains the same relation as it descends

towards the wrist. It covers the supinator radii brevis, and the extensors of the thumb at their origin ; and as the tendons pass along the metacarpal bones, the two inner ones are connected to one another by slips of communication passing obliquely between them. A synovial membrane encases the tendons as they pass under the annular ligament.

468. *m. Extensor digiti minimi*, fig. 104, 6, is usually united with the common extensor, and has been considered by some as a part of it. It is placed between the muscle last named and the extensor carpi ulnaris. It *arises* in common with the extensor communis, and presents, as it descends along the arm, a thin fleshy belly, which ends in a tendon that passes through a ring in the annular ligament appropriated to itself. This will be observed to join with the fourth digital tendon of the common extensor, conjointly with which it expands upon the posterior surface of the phalanges of the little finger.

469. *m. Extensor carpi ulnaris*, fig. 104, 7, lies towards the ulnar border of the fore-arm, being extended from the external condyle to the root of the little finger. It *arises* from the posterior surface of the external condyle by a tendon common to it, the extensor communis, and extensor carpi radialis; some fibres are also derived from the septa that lie between it and these muscles, as well as from the fascia of the arm. The muscle inclines somewhat inwards, and ends in a tendon, which runs through a groove appropriated to it in the carpal end of the ulna, and, after passing between the carpus and annular ligament, is inserted into the posterior extremity of the metacarpal bone, sustaining the little finger. It is covered only by the skin and fascia.

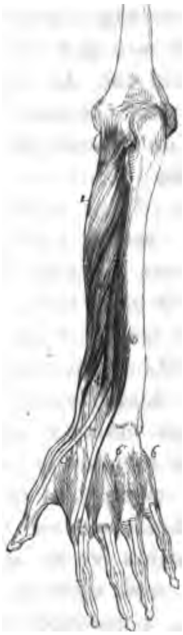
BRACHIAL REGION (DEEP, POSTERIOR).

The deep-seated muscles on the back of the arm are all less in size and length than the superficial set, from which they are readily distinguishable by the obliquity of their direction.

Dissection.—When the long extensors which arise from the external condyle have been examined, they may be detached from their origin, and drawn outwards, so as to expose those which lie deeply between, or on the bones. The supinator brevis and anconeus, both short muscles, and oblique in the direction of their fibres, will be seen close below the elbow-joint, whilst the extensors of the thumb, and the indicator, lie obliquely over the middle and lower part of the radius.

470. *m. Extensor ossis metacarpi pollicis*, fig. 105, 2, (abductor longus pollicis, Sœmm.) This muscle, the extensor of the metacarpal bone, descends obliquely over the bones of the fore-arm, lying immediately below the border of the supinator brevis. It *arises* from the external surface of the ulna, as well as from the inter-osseous ligament and radius, as it crosses each; its fleshy belly ends in a tendon, which passes through a groove in the outer border of the radius, common to it and the extensor of the first phalanx of the thumb, and is inserted into the base of the metacarpal bone of the thumb. The origin and upper part of the muscle are concealed by the common extensor, but it becomes superficial where it lies on the external border of the radius; and whilst passing over the carpus, its tendon crosses those of the radial extensors.

Fig. 105.



471. *m. Extensor primi internodii* pollicis, fig. 105, 3, (the extensor of the first phalanx,) is much smaller than the preceding, and lies close to its lower border. The muscle *arises* from the inter-osseous ligament and radius, and slightly, if at all, from the ulna; it takes the same direction as the abductor, which it accompanies through the groove in the radius, and over the corresponding border of the carpus; its tendon proceeds onwards to the thumb, and is inserted into its first phalanx.

472. *m. Extensor secundi internodii* pollicis, fig. 105, 4, (the extensor of the second phalanx) is much larger than the preceding muscle, which it partly covers; its direction is obliquely downwards and forwards from the ulna to the thumb. It *arises* from the back part of the ulna, immediately below the great abductor, and from the adjacent part of the inter-osseous

ligament. The fleshy belly derived from these attachments soon ends in a tendon, which, like the others, is bound down by the annular ligament, and runs through the narrow oblique groove at the middle of the carpal end of the radius, and is finally inserted into the base of the second phalanx of the thumb. Whilst passing along the groove, its tendon is separated from those of the other extensors of the thumb by the breadth of the interval which lodges the radial extensors; but it gradually inclines towards them as it proceeds to its destination.

473. m. *Extensor indicis*, fig. 105, 5, (indicator,) is nearly of the same size as the preceding muscle, whose lower border it accompanies. It *arises* from the posterior surface of the ulna, about its middle, also from the inter-osseous ligament. The tendon, which is continued from the muscular part, passes, together with the common extensor, beneath the annular ligament, comes in contact with the digital tendon of the latter, which is destined for the index finger, and unites with it to form the tendinous expansion by which both are inserted into the posterior surface of the phalanges.

474. m. *Supinator radii brevis*, fig. 105, 1, is a short triangular muscle, lying in close contact with the bones, and extended obliquely from the outer condyle of the humerus over the upper third of the radius. It *arises*, by a short tendon, from the external condyle, and from the external lateral ligament, as far as its insertion into the annular ligament of the radius, also from a rough ridge on the back part of the ulna, and, in the interval between the bones, from a slight band of tendinous fibres stretched from the ridge just mentioned to the condyle. The fibres of the muscle, from these points of attachment, pass obliquely over the head and upper part of the radius, and are inserted into the oblique ridge that leads from the tubercle of that bone downwards and outwards to the insertion of the pronator radii teres. It is altogether concealed by the supinator longus and the extensors.

Combined Actions.—These muscles act on the fingers and hand in the first instance, and then, by a continuance of their effort, on the fore-arm, which they assist in extending. The common extensor, as well as those of the thumb, the fore-finger, and little finger, are, from their situation and attachments, the direct antagonists of the flexors;

the latter, however, being, from their size and number, the more powerful agents. If the bones of the thumb be drawn inwards to the palm, as when an object is firmly grasped, their extensor muscles may, by reason of the obliquity of their direction, assist in supinating the hand. Their names indicate their more ordinary action. The anconeus assists the triceps in extending the fore-arm. The supinator brevis turns the radius on its axis, so as to bring the hand into the supine position.

Muscles of the Hand.

The muscles of the palm of the hand admit of being divided into three sets or groups, viz. those of the thumb, those of the little finger, and thirdly, those placed in the middle of the palm. The extensors, which have been described in the foregoing sections, and the dorsal inter-ossei, are the only muscles on the back of the hand.

Dissection.—The first step in the dissection of the hand consists in exposing the palmar fascia in its entire extent (for its description see section 581). For this purpose a transverse incision may be made at the wrist, down to the annular ligament; for, as the fascia arises from it, it affords an easy guide to that membrane. The integument may then be raised, and reflected forwards to the fingers, or to either side. When the fascia has been examined, it may be detached from its connexion with the annular ligament, and removed altogether, by which means the flexor tendons, the superficial arch of arteries, and the branches of the ulnar and median nerves, are brought into view. The digital prolongations of these different structures can, in the next place, be traced along the fingers by merely removing the integument. The short muscles of the thumb, and those of the little finger, may next engage attention. But it will not be necessary to add anything to what is stated in the description of the muscles, as they are placed in their anatomical order, care being also taken to indicate their situation and general characters, so that no mistake can occur. Deep in the palm of the hand are situated one set of inter-ossei muscles; these cannot be seen until the flexor tendons are all removed. The extensor tendons must be displaced, in order to expose fully the dorsal inter-ossei. Particular attention should be paid to the position of the superficial palmar arch of arteries, as well as to its digital branches.

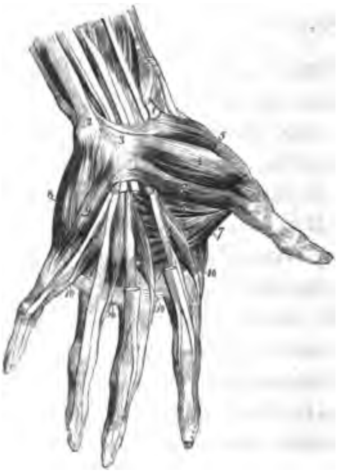
EXTERNAL PALMAR REGION (MUSCLES OF THE THUMB).

The fleshy mass which forms the ball of the thumb consists of four muscles, which are inserted into its metacarpal bone and the first phalanx.

475. *m. Abductor pollicis*, fig. 106, 4, is a flat, narrow muscle, placed immediately beneath the skin. It arises from the annular ligament of the wrist, 3, and from the os trapezium, and proceeds outwards and forwards, to be inserted, by a short thin tendon, into the base of the first phalanx of the thumb, at its radial border. The muscle is superficial in its entire extent, and rests on the opponens pollicis.

476. *m. Opponens pollicis*, fig. 106, 5; fig. 107, 2, is placed beneath the preceding, but its borders project laterally, so as to be perceptible at each side of it. The fibres of the muscle arise from the annular ligament and from the os trapezium, and thence proceed outwards and forwards, to be inserted into the whole length of the metacarpal bone of the thumb, at its radial border. One surface is covered by the abductor and integument, the other rests on the short flexor.

Fig. 106.



477. *m. Flexor brevis pollicis*, is larger than either of the preceding muscles, beneath which it is placed. Its carpal extremity is divided into two processes or heads, 6, 6, the interval between which transmits the tendon of the long flexor. One of these, which is anterior, and therefore superficial, relatively to the other, arises from the inner surface of the annular ligament, and from the os trapezium; the other is attached to the os trapezoides and os magnum. The fleshy fibres from these points of origin soon unite to form a single mass, which, however, again resolves itself into two short processes, which are inserted into

the opposite borders of the base of the first phalanx of the thumb. In each of these tendinous heads a sesamoid bone is placed, where it passes over the first joint of the thumb.

478. *m. Adductor pollicis*, fig. 106, 7; fig. 107, 4, is placed still more deeply than the short flexor, being extended from the metacarpal bone that sustains the middle finger, to the base of the first phalanx of the thumb. Its form is triangular, the base being attached to the former bone, the apex to the latter. It arises from the palmar border of the third metacarpal bone, from which its fibres proceed outwards, converging to a short tendon, which is inserted into the base of the first phalanx of the thumb, where its fibres are blended with the inner insertion of the short flexor, fig. 107, 3.

Combined Actions.—The names applied to the muscles of the thumb sufficiently indicate their actions and use; they are eight in all, and may be arranged as follows. In the first place, it should be recollected that there are three movable osseous pieces in the thumb, so articulated as to admit of the four movements of extension, flexion, abduction, and adduction. There are three extensors, one for each bone, viz. the extensor of the metacarpal bone, and those of the first and second phalanges; these are long muscles, placed on the dorsal aspect of the fore-arm and hand. Opposed in situation and action to these are the three flexors, lying on the palmar aspect of the thumb, viz. the opponens (which may be considered a flexor of the metacarpal bone), the flexor brevis, or flexor of the first phalanx, and flexor longus, which is the flexor of the second phalanx. There remain the abductor and adductor, which likewise are opposed to one another in situation and action; one being superficial and external, and therefore well calculated to draw the thumb away from the fingers, whilst the other is internal and deep-seated, and thereby enabled to approximate it to them. If these moving powers be made to act successively, circumduction is performed; or, in other words, the thumb moves so as to describe a cone, whose summit is at its carpal articulation, and base at the line traversed by its extremity.

INTERNAL PALMAR REGION (MUSCLES OF THE LITTLE FINGER).

The thick fleshy mass at the inner border of the hand also consists of four muscles, one of them being cutaneous; the others are the proper muscles of the little finger.

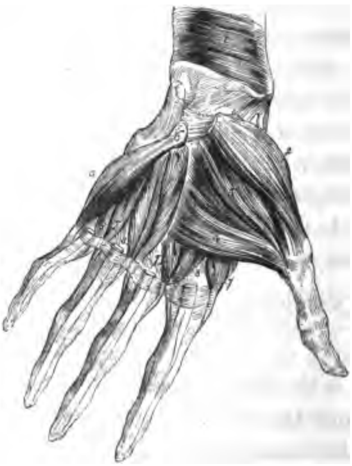
479. *m. Palmaris brevis*, fig. 102, 12, forms a thin plane of pale fibres placed immediately beneath the skin. It arises from the annular ligament and palmar fascia, from which its fibres proceed inwards, diverging, and are inserted into the skin along the inner border of the palm of the hand. It is superficial to the palmar fascia, as well as to the muscles of the little finger.

480. *m. Abductor digiti minimi*, fig. 106, 8, runs along the ulnar border of the palm of the hand, arising by tendinous fibres from the pisiform bone, 2, and annular ligament, where they are blended with the insertion of the flexor carpi ulnaris. The fleshy belly, of which the muscle consists, ends in a tendon, which is inserted into the base of the first phalanx of the little finger at its ulnar border. The muscle rests on the fifth metacarpal bone, and on the opponens or adductor of the little finger, and is covered by the palmaris brevis and palmar fascia.

481. *m. Flexor brevis digiti minimi*, fig. 106, 9, is placed on the same plane with the abductor, lying close to its palmar border. It arises from the anterior surface of the annular ligament, and from the unciform bone, and is inserted into the base of the first phalanx of the little finger. In some instances the flexor does not exist, in which cases the abductor is found larger than usual. From this circumstance, as well as from its position and direction, it may be inferred that, in addition to its ordinary action of abduction, the last-named muscle can become also a flexor.

482. *m. Adductor vel opponens digiti minimi*, fig. 107, 5, is somewhat triangular in its form, and placed under cover of the others. It arises from the annular ligament, and from the hooked process of the unciform bone, 6, from which the fibres incline forwards and inwards, to be inserted into the whole length of the fifth metacarpal bone.

Fig. 107.



MIDDLE PALMAR REGION.

The muscles placed in the space intervening between the two borders of the hand, are the lumbricales and inter-ossei.

483. *m. Lumbricales*, fig. 106, 10, are four tapering, fleshy fasciculi, extended from the tendons of the flexor profundus to the first digital phalanges, and are therefore but accessories or appendages to that muscle. They arise by fleshy fibres from the outer or radial border of the flexor tendons, and proceed forwards to the corresponding sides of the fingers, where they are inserted into the tendinous expansion covering the dorsal aspect of the fingers. They are covered by the palmar fascia, and partially by the tendons of the flexor sublimis.

The *inter-ossei* are divided into two sets, viz. those which are perceptible at the dorsal aspect of the metacarpus, and those placed in the palm.

484. The *dorsal inter-ossei*, fig. 105, 9, 66, are four in number, one of them being usually known as the abductor indicis, and placed amongst some of the other groups of muscles, though in position, mode of attachment, and structure, it is strictly an inter-osseous muscle. The general characters of these muscles are, that they lie between the metacarpal bones, and appear on their dorsal aspect, yet project into the palm where they are shown, fig. 107, 7, 7. They arise from the contiguous sides of the bones, between which they are placed, by fibres that converge to a common tendon; each is, moreover, bifid at its carpal extremity.

485. The *first dorsal* inter-osseous muscle, fig. 105, 9, (*abductor indicis*) is larger than the others, and lies in the interval between the thumb and the index finger. It arises by two heads, of which one, external and larger, is attached to the ulnar border of the first metacarpal bone, the other to the contiguous margin of the second, the angular interval between them serving to transmit the radial artery into the palm of the hand. Both soon unite, and become inserted, by a thin tendon, into the base of the first phalanx of the index finger, where its fibres also unite with those of the extensor tendon. The *second* dorsal inter-osseous muscle lies in the second metacarpal space. It arises from both bones, and is inserted tendinous into the radial border of the extensor tendon, covering the first phalanx of the middle

finger, and into the base of that phalanx. The *third*, similarly placed in the third metacarpal space, is inserted into the opposite or ulnar border of the tendinous expansion of the extensor communis, which covers the middle finger; and the *fourth*, lying in the corresponding space, is inserted into the ulnar side of the ring finger, by becoming attached to the tendinous expansion that covers it. These are also connected with the bases of the first phalanges.

486. The *palmar inter-ossei* lie rather on the palmar surface of the bones than in their intervals, fig. 107, 8. They are three in number, and are undivided at their origin. The *first* palmar inter-osseous muscle arises along the ulnar border of the second metacarpal bone, and is inserted at the same side of the base of the first phalanx of the index finger, where the fibres of its tendon are blended with those of the extensor communis. The *second* arises from the radial border of the fourth metacarpal bone, and is inserted into the base of the first phalanx of the ring finger, by its radial border. The *third* arises from the radial side of the fifth metacarpal bone, and is inserted into the base of the first phalanx of the little finger, by its outer or radial border. The second and third, like the first, have also a connexion with the extensor tendons.

Thus, the index and ring fingers have each two inter-ossei muscles (one palmar, and one dorsal); the middle finger has two of the dorsal set, and the little finger has one of the palmar.

Actions.—All the inter-ossei muscles act on the first phalanges of the fingers. They obviously possess the power of adduction and abduction, according to the manner of their insertion, and so can make the fingers diverge from or approach to one another. The dorsal set may, to a certain extent, assist the extensor communis in extending or drawing back the fingers; and again, if the fingers be but slightly bent, as the direction of the inter-ossei in that position forms an angle with that of the phalanges, they may assist in drawing them to the palm of the hand, that is, in flexing them.

ABDOMINAL REGION.

487. The abdominal muscles consist of three broad lamellæ on each side, a pair (usually two pair) in front, flat, elongated, and enclosed within the aponeurotic expansions of the former;

and another pair, situated posteriorly, beside the vertebral column, which are contained within a similar expansion prolonged from one of the lateral muscles to the lumbar vertebræ.

Dissection. To expose the external oblique muscle:—When commencing the dissection of the abdominal muscles, an incision may be made through the skin from the ensiform cartilage to the umbilicus, and another from thence to the most depending part of the margin of the thorax. The angular flap of skin, bounded by these lines, may be easily reflected by commencing at its point, and taking the tendinous fibres of the external oblique muscle as a guide, each stroke of the scalpel being directed obliquely upwards and outwards. The flap should be reflected until its base, or attached border, is brought on a line with the ensiform cartilage, or somewhat higher, which is necessary in order to expose the digitated processes of the muscle, and their intermixture with those of the serratus magnus. An incision may, in the next place, be carried horizontally inwards from the anterior superior spinous process of the ilium to the linea alba, and there met by another drawn down from the umbilicus. The enclosed flap of skin should be reflected back to the posterior part of the lumbar region. If it be required to exhibit the muscle in its entire extent, the portion of integument still remaining on the lower part of the abdomen may be divided by an incision drawn from the pubes upwards, and the flap reflected down over Poupart's ligament. For the present, however, we shall leave untouched the integument, muscle, &c. in the iliac region, as they will require to be examined attentively when treating of the dissection of the parts connected with hernia.

To expose the internal oblique muscle:—When the external oblique muscle has been examined, it may be detached and reflected so as to bring into view the one subjacent to it, by cutting through its muscular fibres midway between its digitations and the margin of the ribs. Its posterior, or free border, will be found extending from the last rib to the crista of the ilium, and can be readily distinguished from the internal oblique muscle by the different course of its fibres. When this is effected, the fleshy fibres can be dissected from the crista ilii, as far as its spine, and the whole plane of muscle turned over to the opposite side. The internal oblique is thus exposed for two-thirds of its extent.

To expose the transversalis muscle:—When the examination of the internal oblique muscle has been completed, it is said to be difficult to detach it without injuring the muscle beneath it; yet, if just above the spine of the ilium the fibres be rendered tense by pressing the thumb and fore-finger of the left hand on them, and so straining the interval, they can be divided with perfect precision, without interfering with the subjacent muscle; for the fibres are retracted when divided, and after about three parts are cut through, the cellular interval between the muscles begins to be perceived, which, with the difference in the direction of their fibres, affords an unerring guide to their line of separation. Moreover, near the spine and crista of the ilium, these muscles are separated by the circumflex (ilii) vessels; and this is the part usually selected for cutting through the internal oblique, in order to expose the transversalis. When the line of separation is found, the muscular fibres should be detached from the crista ilii far back towards the lumbar region; after which they may be dissected from the cartilages of the ribs by insinuating the scalpel between the two planes of fibres, and then turning it so as to cut outwards. In this way the internal oblique muscle may be detached from its connexions, and reflected to the opposite side, exposing the transversalis.

To expose the rectus muscle:—The sheath of the rectus muscle should in the next place be examined. Its mode of formation is fully described (sect. 492). Its anterior layer must be divided in its whole length, by an incision drawn down from the margin of the thorax to the pubes, and reflected off the rectus. By inserting the handle of the scalpel beneath the outer border of the muscle, it may be raised, and the posterior layer of the sheath brought into view. Lastly, if the muscle be cut across midway between the umbilicus and pubes, and the two parts drawn aside, the point at which the sheath is imperfect, posteriorly, can be determined by pushing the handle of the scalpel against it, so as to separate it from the subjacent membrane.

488. *m. Obliquus externus abdominis*, fig. 99, 9, (obliquus descendens; costo-abdominalis; ilio-pubi-costo-abdominalis,) is situated on the lateral and anterior parts of the abdomen; its form being broad, thin, and irregularly quadrilateral. It arises from the anterior surfaces of the eight inferior ribs, by fleshy fibres arranged in so many angular processes, named digitations, of which five meet an equal number of similar prolongations from the serratus magnus muscle, and three with those of the latissimus dorsi. The fleshy fibres from the last ribs pass down to be inserted into the external margin of the crista ilii, the anterior half of its length; all the rest pass downwards and forwards, and terminate in tendinous fibres, which form a broad

aponeurosis, 13, that covers the entire front of the abdomen, and terminates by uniting with that of the corresponding muscle along the median line, 12, from the ensiform cartilage to the symphysis pubis. The inferior fibres of this aponeurosis are closely aggregated together, and extended across from the anterior superior spinous process of the ilium to the os pubis, in the form of a tense band, 11, which is called *Poupart's ligament.* Near the pubes the fibres diverge from one another, leaving between them a triangular opening, 10, for the passage of the spermatic cord in the male, and the round ligament in the female. The direction of this opening, called the *external abdominal ring*, is upwards and outwards, its base being formed by the crista of the os pubis, and the sides by the two sets of diverging fibres, called its *pillars*, of which one is attached to the anterior surface of the symphysis pubis, interlacing with the corresponding fibres of the opposite muscle; the other, external and inferior, is fixed to the spinous process of the pubes; whilst a third portion, reflected backwards and outwards from the latter, is inserted along the pectineal line, being triangular in its form, and nearly horizontal in its direction, and ordinarily denominated *Gimbernat's ligament.* The direction of the fibres of this muscle is obliquely downwards and inwards: structure—fleshy where it is attached to the thorax and ilium, aponeurotic in the rest of its extent: relations—externally with the skin and superficial fascia, internally with the cartilages of the ribs, obliquus internus, rectus, and pyramidalis muscles; posteriorly, its border is overlapped a little by the latissimus dorsi.

489. *m. Obliquus internus*, fig. 99, 14, (obliquus ascendens; ilio-abdominalis; ilio-lumbo-costi-abdominalis,) placed under cover of the preceding muscle, is of an irregularly quadrilateral form. It *arises* inferiorly from the external half, not unfrequently from two-thirds of the inner surface of Poupart's ligament, from the crista ilii for two-thirds of its length, also from a thin aponeurosis, prolonged backwards to the lumbar vertebræ. This aponeurosis is attached below to the crista ilii, above connected with the serratus posticus inferior, and posteriorly, after contracting an intimate union with the latissimus dorsi, becomes exceedingly thin, and in a manner identified with the aponeurosis of the latter, with which it extends back to the spinous processes of the lumbar vertebræ. From these attachments, the

fibres of the muscle pass with different degrees of obliquity, to be inserted as follows: those from Poupart's ligament arch downwards and inwards, to be fixed into the crista of the pubes, and also for some way into the pectineal line, conjointly with those of the transversalis muscle; or, more strictly, into Gimbernat's ligament, where it is inserted into that line. The fibres, from the anterior part of the crista ilii, pass horizontally inwards, whilst the rest ascend obliquely, and terminate, some in an aponeurosis expanded in front of the abdomen, the rest at the lower margin of the cartilages of the last four ribs, on a plane corresponding with the intercostal muscles. The aponeurosis divides at the outer border of the rectus muscle into two lamellæ, one passing before, the other behind it, and reuniting at its inner border, so as to enclose it in a sheath. The anterior lamella becomes identified with the aponeurosis of the external oblique muscle. The upper border of the posterior lamella is attached to the margin of the first false and the last true ribs, and also to the ensiform cartilage. At the inner border of the rectus muscle, this aponeurosis joins with that of the opposite muscle, and with the external oblique, so as to form with them the linea alba. Direction—obliquely upwards and inwards in the greater part of its extent; some of its fibres are horizontal, the rest are arched downwards: structure—fleshy at the sides, aponeurotic anteriorly and also posteriorly, where it becomes connected with the lumbar vertebræ: relations—by one surface with the obliquus externus, by the other with the transversalis; anteriorly with the rectus and pyramidalis, which its aponeurosis serves to enclose, posteriorly with the latissimus dorsi and the deep-seated lumbar muscles.

490. *m. Cremaster*, fig. 99, 15. Though the cremaster, or suspensory muscle (*κρεμαω*, to suspend) of the testis, does not form a part of the abdominal parietes, its description usually follows that of the internal oblique, in consequence of the intimate connexion which subsists between them. It is ordinarily said to arise from the inner surface of Poupart's ligament, and from the lower border of the internal oblique muscle, a few fibres also appearing to come from the transversalis; from these origins the fibres pass downwards on the spermatic cord, and are lost on the tunica vaginalis testis. When examined with attention, the cremaster appears to consist of two fasciculi; of which

the external and longer descends from the lower border of the internal oblique muscle, the other, internal and smaller, being attached to the crista of the os pubis. From these points of attachment the fibres descend through the external abdominal ring, converge and unite so as to form arches whose convexity looks downwards, their degrees of obliquity increasing as they descend. The cremaster does not exist as a distinct muscle before the descent of the testis.* In the fœtus of five months old, the inferior fibres of the internal oblique arch downwards and inwards, from Poupart's ligament to the crista of the pubes, passing over a delicate greyish fasciculus, the gubernaculum testis, which alone occupies the inguinal canal at that period. The gubernaculum is intimately connected with these fibres of the internal oblique, and if it be drawn downwards, they may be made to descend through the ring, and if retained in this situation they will strictly resemble the cremaster in direction and attachments. This experiment at once points out the manner in which the cremaster is produced; it shows that the fibres of which it consists were originally part of the inferior oblique muscle, and that, as the testis passes from the abdomen into the scrotum, they are drawn along with it, by reason of the intimate connexion subsisting between them and its gubernaculum. The testis sometimes passes between the fibres of the internal oblique; when this occurs, some will lie behind the cord, others (usually the greater number) before it, so that it is completely invested by them.

491. ***m. Transversalis abdominis*** **(transversus abdominis, Sœmm.; lumbo-abdominalis).**

Dissection.—A membranous prolongation from the transversalis muscle forms an investment for the quadratus lumborum, (sect. 494,) similar in many respects to the sheath of the rectus. Let us suppose that it is intended to examine this structure on the right side; it will be found convenient to lay the subject on the left, and to have it secured in that position. If the internal oblique be traced back, its muscular fibres will be found to end in an aponeurosis, which becomes intimately connected externally with the latissimus dorsi, close to the border of the deep lumbar muscles, and internally with the transversalis. Now, if the aponeurosis of the latissimus be divided in the middle of its breadth, by an incision drawn from the ilium to the last rib, and the two parts reflected, the thick mass of lumbar muscles will be exposed; and if the handle of the scalpel be inserted beneath their outer border, they will be found to lie on a membrane, which is connected with the lumbar vertebræ on the one hand, and with the abdominal muscles on the other, being, in fact, a prolongation of the latter. The mass of lumbar muscles may now be cut across by two incisions, one opposite the last rib, the other at the crista ilii, and then removed altogether. When this is effected, if attention be directed to the internal oblique muscle, it will be found that the aponeurosis, in which it ends posteriorly, after contracting adhesion to the transversalis, as above stated, becomes connected with the aponeurosis of the latissimus dorsi, and with it prolonged to the spinous processes of the vertebræ behind the lumbar muscles. In this stage of the dissection, a thin lamella will be found stretched back from the transversalis to the transverse processes of the lumbar vertebræ. If this be divided by a perpendicular incision from the last rib to the ilium, the quadratus lumborum will be exposed; and if the external border of this muscle be raised, another thin layer will be found resting on its abdominal surface, and connected with the roots of the transverse processes. Thus, the posterior aponeurosis of the transversalis muscle, by dividing into two lamellæ, encloses the quadratus as in a sheath. We have thus traced four layers of fibrous structure, connected with muscles in the lumbar region, viz. the thick broad aponeurosis of the latissimus dorsi, the thin one of the obliquus internus, and that of the transversalis, which divides into two. The term *fascia lumborum* is applied by some to the aponeurosis of the latissimus, by others to the lamellæ prolonged back from the internal oblique and transversalis. It is not applicable to either, and conveys no definite idea of any of the parts seen in this region.

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* Recherches Anatomiques sur les Hernies, par Jules Cloquet.

When this part of the dissection has been completed, the subject may be turned on its back, in order that the inguinal region may be examined, which is an indispensable preliminary to a correct knowledge of the structure of the parts connected with those intestinal protrusions to which the term hernia is applied (ἑρνος, *a tumour*). It will be recollected, that the dissections made with a view to exhibit the abdominal muscles (sect. 487), may be so conducted as to leave an angular flap of integument covering the inguinal region. The skin alone should be raised over this part, and reflected down on the fore part of the thigh, for about three inches below Poupart's ligament, without disturbing the layer of cellular membrane that lies beneath it.

This we shall describe as the superficial fascia of the abdomen (sect. 592), to which the reader is referred; and for the surgical anatomy of inguinal hernia to sect. 593.

The transversalis muscle, fig. 108, 4, is subjacent to the internal oblique, and of the same form; it arises from the iliac half of Poupart's ligament, from the inner margin of the crista ilii for three-fourths of its length, from the cartilages of the six or seven last ribs, and, in the space intermediate between the crista and the ribs, from an aponeurosis (see Dissection,) which is attached to the transverse processes of the lumbar vertebræ. From these different points of origin the fibres pass horizontally forwards, and near the border of the rectus muscle end in an aponeurosis, 5, which joins with the posterior layer of the internal oblique, and, together with it, is inserted into the whole length of the linea alba; the inferior fibres curve downwards, and are inserted into the crista of the os pubis, and into the pectineal line. This insertion is so intimately connected with that of the internal oblique, that both together have received the name of the conjoined tendon, 6, or aponeurosis, of these muscles. At its attachment to the cartilages of the ribs, it digitates with the diaphragm, and is continuous with it in the two last intercostal spaces. Relations — externally, with the obliquus internus; internally, with the fascia transversalis, which separates it from the peritonæum: structure—muscular at the sides; aponeurotic anteriorly and also posteriorly, where it is prolonged to the vertebral column, and forms a sheath for the quadratus lumborum.

492. *m. Rectus abdominis*, fig. 99, 16; fig. 108, 3, (sterno-pubius,) long, narrow, and flat, is situated at the fore part of the abdomen, close to the linea alba. It *arises* from the anterior surface of the ensiform cartilage and its external ligament, also from the cartilages of the fifth, sixth, and seventh ribs, by separate fleshy points, and is inserted by a strong flat tendon into the crista of the os pubis, its fibres being extended perpendicularly between these points. They are, however, interrupted by irregular tendinous intersections (*lineæ transversæ*), varying in number from three to five. One of these corresponds with the umbilicus, another with the ensiform cartilage, the third intermediate between them, and if a fourth exists, it is placed below the umbilicus; so is the fifth. These lines do not usually penetrate the whole substance of the muscle, and some of them

extend only half-way across it. This muscle is enclosed in a sheath (*sheath of the rectus*), formed by the aponeuroses of the abdominal muscles, in the following manner: the aponeurosis of the internal oblique, on arriving at the external border of the rectus muscle, divides into two lamellæ, of which the anterior one passes in front of the rectus, together with the aponeurosis of the external oblique, whilst the other passes behind it, conjointly with that of the transversalis, becoming again united along the linea alba. This arrangement obtains from the margin of the thorax, as far as to midway between the umbilicus and the pubes, but at this point all the aponeuroses pass in front of the rectus; so that the posterior part of its sheath is deficient in the lower third, the muscle being separated from the peritonæum by the fascia transversalis only. The deficiency in the sheath here indicated is marked by a well-defined lunated edge, whose concavity looks downwards towards the pubes.

493. *m. Pyramidalis*, fig. 99, 17, triangular in its form, and situated close to the linea alba, arises from the crista of the os pubis, and, becoming narrow as it ascends, is inserted into the linea alba about midway between the umbilicus and pubes; its internal fibres are vertical in their direction, the others more or less oblique. It is covered in front by the aponeuroses of the other muscles, and posteriorly rests on the rectus, of which it may be regarded as an accessory; its more direct action is that of a tensor to the linea alba.

494. *m. Quadratus lumborum*, fig. 98, 16, (ilio-costalis,) situated deeply in the lumbar region close to the vertebral column, is in form irregularly quadrilateral, being somewhat broader below than above. It arises by tendinous fibres from the crista of the ilium for about one-fourth of its extent, and from the ilio-lumbar ligament; it is inserted into the inferior border of the last rib for about half its length, and by four tendinous points into the transverse processes of the four superior lumbar vertebræ. This muscle is enclosed in a sheath (*sheath of the quadratus*) not unlike that of the rectus, but not so dense or firm in its structure. The posterior or lumbar aponeurosis of the transversalis divides into two layers near the border of the quadratus, one of which is prolonged backward behind the latter muscle, to be attached to the apices of the transverse processes of the lumbar vertebræ, and the other before it to be fixed

at the roots of these processes. Now, the lower border of this layer is attached to the inner margin of the crista ilii (its posterior fourth), and the upper one is stretched across from the anterior surface of the last rib to the root of the transverse process of the first lumbar vertebra. This latter part, from its mode of attachment and relation to the broad muscle of the diaphragm, has been named by some ligamentum arcuatum externum (sect. 501).

Along the fore part of the abdomen some tendinous structures exist which require a special notice, viz. the linea alba, lineæ semi-lunares, and transversæ.

495. The *linea alba* may be considered as a tendinous cord, fig. 99, 12, formed by the juncture of the aponeuroses of the two obliqui and transversales muscles, and extended perpendicularly downwards from the ensiform cartilage to the pubes. It is covered in front by the common integument; posteriorly it rests on the fascia transversalis, which separates it from the peritonæum, and on each side it is enclosed by the recti muscles; it is therefore broader above than below, as these muscles diverge from one another in the former situation. In the middle of the linea alba is situated the umbilicus, which in the fœtal state is a foramen for the transmission of the umbilical vein and arteries, but afterwards becomes obliterated.

496. The *lineæ semi-lunares* are two curved lines extending from the cartilages of the eighth rib, on each side, to the tuberosity of the os pubis. They thus correspond with the external borders of the recti muscles (the enclosed space being broad above and narrow below), and are formed by the aponeurosis of the internal oblique on each side, as it divides to enclose the rectus muscle.

The *lineæ transversæ* have been already noticed with the rectus muscle, in the substance of which they are situated (sect. 492.)

Actions.—The muscles here described not only enclose and support the abdominal viscera, but by their contractile power are capable of acting successively on them, on the thorax, and on the pelvis. When the pelvis and thorax are fixed, the abdominal muscles can constrict the cavity and compress its viscera, particularly if the diaphragm be made to descend at the same time, as occurs in vomiting, or in the expulsion of the fœtus, of fæces, or urine. If the vertebral column be fixed, these muscles compress the lower border of the thorax, and so contribute to expiration. When it is intended to continue the effort, so as to produce a forced expiration, the quadratus lumborum draws down the last rib, and makes it relatively the fixed point to which all the rest are drawn by their inter-costal muscles; but if the vertebral column be not fixed, the thorax may be bent directly forwards, when the muscles of both sides act; or it may be rotated to either side, should they act alternately. Thus, if the external oblique of the right side be made to act on the thorax, the first effect appears to be that of drawing its margin down towards the pelvis; but if the effort be continued, the trunk will be rotated towards the opposite side. The left internal oblique will co-operate in this action, for the direction of its fibres coincides with that of the right external oblique. The pyramidales also contribute to the same effect, by rendering the linea alba tense. If the thorax be fixed, the abdominal muscles may be made to act on the pelvis; thus, in the action of climbing, the trunk and arms being elevated and fixed, the pelvis is drawn upwards, either directly, or to one side, as a preparatory step to the elevation of the lower limbs. A similar effect may be produced when the trunk is in the horizontal position, for the pelvis may be drawn forward and flexed upon the vertebral column by the recti and pyramidales.

COSTAL REGION.

Between the ribs we find a series of flat planes of muscular fibres filling up the intervening spaces, hence named "intercostal,"—upon the ribs posteriorly the levatores costarum, and at their inner surface, and in front, the triangulares sterni.

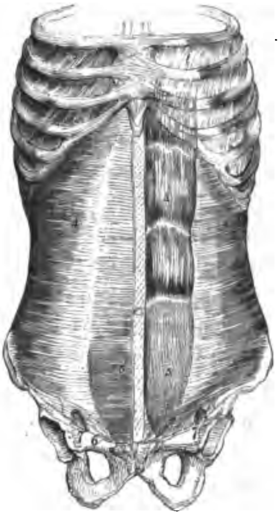
It is not necessary to prescribe any particular mode of examining these, as they are necessarily exposed when the pectoral, the serratus, and external oblique muscles are removed.

The inter-costal muscles are disposed in the form of two thin planes, one external, the other internal.

497. *m. Inter-costales externi* are placed between the contiguous borders of each pair of ribs. There are, therefore, eleven such muscular lamellæ on each side, the direction of the fibres of all being obliquely downwards and forwards, fig. 108, 1. Their extent in each instance is from the tubercles of the ribs nearly to the external extremity of their cartilages. From this point a thin fascia is continued forwards to the sternum, overlaying the inner inter-costals.

498. *m. Inter-costales interni*, commencing at the sternum, in the spaces between the true ribs and in the rest, from the anterior extremities of their cartilages, extend as far back as their angles, the direction of their fibres being obliquely downwards and backwards, fig. 108, 2; thus they decussate or cross the former.

Fig. 108.

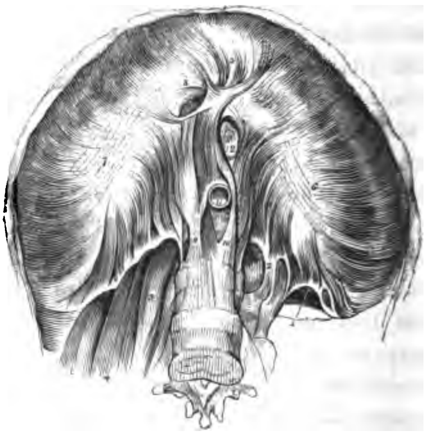


499. *m. Levatores costarum*, fig. 98, 17, are narrow, tendinous, and fleshy fasciculi, which extend obliquely downwards and forwards (in this particular resembling the external intercostals) from the extremities of the transverse processes of the dorsal vertebræ, to be inserted into the margins of the ribs, between their angles and tubercles. Their fibres spread out and become flat at their insertion.

500. *m. Triangularis sterni* is a thin flat plane of muscular and tendinous fibres, placed within the thorax, immediately behind the costal cartilages. It arises from the inner surface of the ensiform cartilage, and of the lower third of the sternum, from which its fibres pass outwards and upwards, diverging, to be inserted into the lower borders and inner surface of the cartilages of the true ribs, from the sixth to the third inclusive. One surface of the muscle is thus in apposition with the parts just mentioned, the other partly with the pleura, which is reflected upon it, and partly with the pericardium and the cellular interval called anterior mediastinum.

Actions.—The two planes of inter-costals act simultaneously; and as they decussate with one another, the ribs on which they act are made to move in the direction of the diagonal of the moving powers, that is to say, directly upwards when the first rib is relatively the more fixed point, and downwards when the last happens to be so. In drawing up the ribs, they slightly rotate their bodies, and evert their lower borders; at the same time the middle and lower intercostal spaces are widened, for the ribs are spread asunder somewhat like those of a fan. This arises from the peculiar mode of attachment of the last rib, which is prevented from ascending with the rest by the manner in which the quadratus lumborum binds it to the ilium, so that it serves to spread or separate them from one another.

Fig. 109.



501. *m. Diaphragma*, fig. 109, (*διαφϱασσω*, to separate,) is a thin muscular and tendinous partition, placed between the thorax and abdomen. It presents two lateral parts, united along the middle line, but the parts are not symmetrical, on which account it cannot be classed with the muscles of animal life, nor yet with those of organic: in structure it forms a link intermediate between these two orders, and in function partakes of the properties of both, being involuntary in its ordinary actions, yet not altogether withdrawn from the control of the will. The diaphragm, viewed as a whole, consists of three portions, two of which are muscular—the third, which forms the connexion between them, being tendinous. It is broad and expanded at its upper part, and takes the form of the base of the thorax, to which it is attached; therefore its extent, from side to side, is greater than from before backwards. At its inferior and posterior part it becomes constricted into two narrow processes or crura, by which it is attached to the lumbar vertebræ. Its inferior surface is concave, forming an arch which overhangs the cavity of the abdomen; the superior one is convex, but not equally so at both sides, for it ascends higher into the right side of the thorax than into the left. Both surfaces are lined by serous membrane, the inferior by the peritonæum, the superior by the pleuræ at the sides and the pericardium in the middle.

The muscular fibres attached to the margin of the thorax vary in length and direction. Anteriorly at the middle line, the fibres, few in number and short, *arise* from the inner surface of the ensiform cartilage ; this narrow fasciculus is separated at each side by a cellular interval from the fibres attached to the cartilage of the seventh rib. The muscular fibres of each lateral part arise from the inner surface of the cartilages of the ribs, from the seventh to the twelfth inclusive, and from the anterior surface of the body of the last rib for about a third of its length ; finally in the interval between the part of the last rib here indicated and the transverse process of the first lumbar vertebra, they arise from a fibrous band, 1, stretched between these points, which is sometimes termed *ligamentum arcuatum* (see sect. 494). But Haller* very properly distinguishes this from another tendinous lamella, 2, which arches obliquely over the psoas muscle, being attached by one extremity to the transverse process of the first lumbar vertebra (where it is blended with the preceding), and by the other to the body of the second. This he terms " arcus interior :" it may be named *ligamentum arcuatum proprium.* The fleshy fibres from these different points of attachment proceed to their destination in different directions: those in front pass backwards, those at the sides directly inwards, the intermediate ones being oblique; but the fibres from the ligamentum arcuatum externum pass directly upwards, all becoming *inserted* into, or continuous with, the fibres of the central aponeurosis.

502. The *central aponeurosis* (central tendon, cordiform tendon, phrenic centre) is composed of tendinous fibres interwoven in every direction. Its narrow extremity or foot-stalk is turned towards the spine, the wider (which is divided into three processes) towards the margin of the thorax ; hence it was compared by Winslow to a trefoil leaf. The central leaflet or process, 5, is the largest ; the left the smallest, 7 ; the right, 6, being intermediate in size between them. Between the right and middle processes, a little anterior to the spine, is an opening, 8, *(foramen quadratum venæ cavæ,)* for the vena cava ; it is somewhat of a square shape, and resembles rather a canal than a foramen.

503. The *lumbar portion* of the muscle consists of two thick

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* Icones Anatomicæ.

fleshy processes, *crura* or *pillars*, placed at each side of the middle line. The right crus, broader and longer than the left, is attached to the fore part of the bodies of the vertebræ, and to the inter-vertebral fibro-cartilages, whilst the latter inclines rather to their sides. The right crus, 9, arises by fleshy fibres from the three upper lumbar vertebræ, and by a firm tendinous process from the inter-vertebral substance between the third and fourth. The left, 10, does not extend so far down by the breadth of half a vertebra. As they ascend, they leave an interval between them, which lodges the aorta, and opposite the first lumbar vertebra the fibres of each crus proceed to three different destinations. The greater number pass forwards and upwards, to be inserted into the central aponeurosis; those placed towards the sides of the vertebra incline outwards, and terminate upon the surface of the ligamentum arcuatum proprium; but the internal fasciculus of each passes in front of the aorta, so as to complete the canal (*hiatus aorticus*, 11,) which transmits it. The fasciculi decussate at this point; the one from the right side being the larger. After their decussation, the fasciculi are continued obliquely upwards, forming the margins of the opening for the œsophagus (*foramen œsophageum*, 12,) and are ultimately inserted into the central aponeurosis. The œsophagean opening is narrow and elliptical in its form, its greatest diameter being from before backwards, and about an inch and a half in length. It lies a little to the left of, and anterior to, the aortic opening, and transmits the œsophagus with both the vagus nerves. The aortic opening corresponds with the middle line, and gives passage to the aorta, thoracic duct, and also, in most instances, to the vena azygos. The opening for the vena cava lies before and to the right of that of the aorta.

Actions.—The diaphragm is of an arched form, the concavity of the arch looking down into the abdomen. When its fibres contract, the muscle descends, and becomes an inclined plane, whose direction is downwards and forwards. By these means the abdominal viscera are pressed against the lower and fore part of the parieties of the cavity, so that the capacity of the abdomen is diminished in proportion as the thorax is enlarged. Should the abdominal muscles and the diaphragm be both brought into action together, the viscera will be compressed between them, and forced towards the lower part of the cavity, as occurs in the expulsive efforts of accouchement, &c. After a complete expiration, the upper surface of the diaphragm is on a level with the lower border of the fourth rib.

PERINÆAL REGION.

504. This is the space included between the rami of the ischia and ossa pubis at the sides, the symphysis pubis in front, and posteriorly by two lines drawn from the tubera ischii to the coccyx. The muscles contained within this area are divisible into two groups, one connected with the generative organs, and subservient to their peculiar function, the others are attached to the anal extremity of the intestine, and control its excreting action. The genital muscles in the male consist of the erector penis, accelerator urinæ, transversus perinæi, compressor urethræ, compressor venæ dorsalis penis; in the female, of the erector clitoridis and constrictor vaginæ. These are all disposed in pairs. The anal muscles are the sphincter externus and internus, levatores ani, and coccygei.

Dissection of the perinæum.—When viewed externally, this restricted space is observed to be divided into two equal parts, by a continuation of that vertical line which indicates the original division of the body into two symmetrical halves, and which here, as elsewhere, is called the raphé.

To expose the superficial fascia:—A little below the fold of the scrotum, an incision may be made through the skin along the raphé, down to the margin of the anus. At its upper extremity a transverse incision may be made, extending outwards, on the thighs, at each side, for two inches. The flaps of integument may, in the next place, be reflected outwards to the flexures of the thighs, and pinned back. By raising the integument round the anus, the external sphincter muscle will be exposed. The superficial fascia, which is, in fact, nothing more than the sub-cutaneous cellular tissue, having been exposed, its attachments and mode of distribution deserve attention. If it be divided along the middle line, and carefully reflected to each side, it will be found firmly attached to the rami of the ischia and ossa pubis. If traced upwards, or if air, or a jet of water, be passed beneath it, it will be found to be continuous with the sub-cutaneous investment of the scrotum, viz. the dartos, and also with the superficial fascia of the abdomen. A little below the transversus perinæi muscle the superficial fascia will be observed to pass back and become identified with the deep-seated fascia, after which both may be traced beneath the superficial sphincter. When extravasation of urine takes place into the perinæum, the attachments of this fascia will influence the direction in which the fluid proceeds, should its quantity increase. Though its natural tendency is backwards to the anus, or downwards along the inside of the thighs, its progress in these directions is interrupted by the adhesion of the membrane to the rami of the ischia and pubes at each side, and to the deep fascia posteriorly; but towards the scrotum no impediment exists; and so we find that effusions gradually make way upwards to the groin, or even on the front of the abdomen, their progress being preceded by a red erysipelatous blush on the skin.

To expose the superficial vessels and muscles.—Divide the superficial fascia from above downwards in the middle line, and having drawn it aside, and pinned it back on the reflected integument, the superficial perinæal artery will be found running in the angular interval between the accelerator urinæ and erector penis. Midway between the margin of the anus and the bulb of the urethra, a narrowed point (fibrous or fibro-cellular) exists, which forms the *common centre* of the perinæal muscles: to it converge the transversi muscles from the sides, and the sphincter from behind, and from it the lower fibres of the acceleratores diverge. The last-named muscles should be attentively examined, and their description (sect. 506) read, after which they may be divided along their raphé, or common line of junction, and reflected carefully outwards, so as to expose the bulb of the urethra, which will be found invested by a thin smooth lamella, prolonged upon it from the margin of the deep perinæal fascia, through which the canal of the urethra must necessarily pass when emerging from the pelvis into the perinæum. The sphincter ani will be observed surrounding the margin of the anus in the form of a thin flat plane of muscular fibres, similar to orbicular muscles in other situations. On raising its external border, the fibres of the levator ani will be observed passing downwards to the margin of the anus; and further back, in the interval between the posterior margin of that aperture and the tip of the coccyx, the two levatores will be found to form a raphé or line of junction; before the anus their fibres join at the common central point above noticed. To expose the external surface of the levator, all the cellular tissue which fills up the deep interval between the margin of the anus and the tuber ischii must be removed.

To expose the attachments and relations of the levator ani, the interior of the pelvis must be laid open. For this purpose saw through the os pubis half an inch external to its symphysis (say at the right side), the abdominal viscera and peritonæum being previously removed. With your scalpel carefully detach the pelvic fascia from the side of the pelvis, and reflect it inwards, together with the thin membranous muscle you will find attached to its external surface rather low down. When this is done, saw through the right sacro-iliac symphysis, and so remove the whole limb of that side. Let an assistant hold up the levator ani, which you have retained as above directed, and you can easily trace its fibres to the side of the bladder, rectum, and coccyx. And when you have gone so far, draw the bladder away from the left side, and trace down the fascia iliaca upon the side of the pelvis; you will see how it turns inwards to the side of the bladder and rectum. Now, close by these organs you will perceive that behind the fascia there is a thin plane of muscular fibres, the levator ani, of considerable extent, from before backwards, being from the pubic symphysis to the spine of the ischium. If you carefully remove the fascia (proceeding from below upwards) from the muscle, you will see that it is attached to the two points of bone just named, and in the intervening space to the angle of union of the pelvic and obturator fascia. (See description of the deep perinæal fascia, sect. 599, and remarks on catheterism and lithotomy, sect. 600.)

The genital muscles are as follow:

505. m. *Erector penis*, fig. 110, 1, (ischio-cavernosus,) is a thin, flat, long muscle placed on the ramus of the ischium and on the crus of the penis, extending from the inner and upper part of the tuberosity of the ischium to the side of the penis. It is narrow at its extremities, but widens somewhat towards the middle. It arises from the inner border of the tuber ischii, from which its fleshy fibres proceed obliquely upwards and forwards, and become tendinous on reaching the corpus cavernosum, into whose fibrous sheath they are inserted. The inferior surface of the muscle is covered by the skin and the superficial fascia; the superior is in contact with the crus and body of the penis, whilst between its inner margin and the accelerator muscle a groove exists, in which the superficial perinæal vessels are lodged.

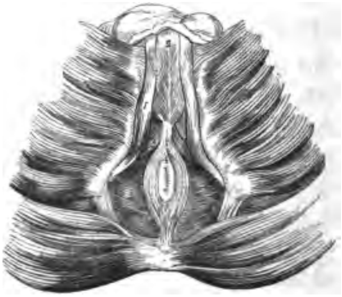
506. m. *Accelerator urinæ*, fig. 110, 2, (bulbo-cavernosus,) is so disposed as to surround the bulbous part of the urethra. We may consider it as a single muscle consisting of two symmetrical halves, united so as to form a tube surrounding a part of the urethra, and connected, anteriorly, by two diverging processes,

with the corpora cavernosa, and posteriorly, at the central point of the perinæum, with the sphincter ani and the transverse muscles, whilst its inferior fibres are extended obliquely outwards at each side to the rami of the ossa pubis. Its analogy with the constrictor vaginæ would lead us to consider it in this way. In conformity with usage, however, we shall describe each lateral half as a separate muscle.

The fibres of the accelerator muscle, forming a thin plane, are blended with those of the corresponding muscle along the middle line, beneath the bulb of the urethra. Their junction extends forwards for three quarters of an inch from the central point above referred to. The fibres from this line of origin proceed in three different directions: the inferior set pass obliquely outwards, and are attached to the angle of union formed by the deep perinæal fascia with the ramus of the pubes; the anterior set incline upwards and outwards, to be inserted into the corpus cavernosum; whilst the intervening or middle fibres coil round the canal of the urethra, and become tendinous on reaching its upper surface, upon which they unite with those of the corresponding muscle, thus forming a tube. If an incision be made over the bulb, so as to cut through the fibres of the muscle, and if one half be then carefully reflected outwards, its points of attachment will be readily seen; after which, if the urethra be cut across and reflected downwards, the union of the middle part of the muscle on its upper surface will be brought into view.

507. *m. Transversus perinæi*, fig. 110, 3, (ischio-perinæalis,) is a narrow fleshy fasciculus, which inclines forwards and inwards across the perinæum, being extended from the inner border of the tuber ischii at its junction with the ramus, to a point midway between the margin of the anus and the bulb of the urethra. The muscles of the opposite sides arise from the inner margin of the tuberosities and the rami of

Fig. 110.



the ischia, and proceed with an inclination forwards, to the point just indicated, where they are blended with the sphincter ani and acceleratores urinæ. Another muscle of this name is occasionally found at each side, lying anterior to the one here described, and called *transversus perinæi alter;* the fibres of the latter are usually thin and pale.

508. *m. Compressor urethræ* (Wilson), compressor prostatæ (Sœmm.), is a narrow fasciculus that arises close by the pubic symphysis, immediately before the anterior fibres of the levator ani, and from which it is merely separated by a small vein and a little cellular tissue. The muscle descends close to its fellow of the opposite side, and, beneath the membranous part of the urethra, both of them having become tendinous, unite so as to support it in a sling. Many persons consider this as but a part of the levator ani.

509. *m. Compressor venæ dorsalis penis* is a small muscle lately demonstrated and described by Mr. Houston.* Cuvier noticed it briefly, and the late Mr. Shekleton showed it to Mr. Houston. It is a thin fasciculus, composed partly of tendinous, partly of fleshy fibres, placed beneath the pubic arch, and above the root of the penis. Its fleshy fibres are attached to the inner margin of the ramus of the os pubis, immediately above those of the erector penis; from this point the fibres ascend, at the same time inclining forwards and inwards, and end in a thin tendon, which unites with that of its fellow of the opposite side, at the median line, just over the dorsal vein. The length of each muscle is about an inch, its breadth about half an inch. As the conjoined tendon of these two muscles overlays the dorsal vein, they can, when in action, compress it against the root of the penis, so as to prevent the return of blood by the vessel, and so keep up the distension of the organ during the venereal orgasm. The general conformation of the muscle corresponds with what has been just stated. There are, however, some peculiarities in different animals which deserve notice. In the dog the tendon presents a transverse slit through which the vein passes; in the horse, the dorsal veins pass backwards in separate trunks, and the tendon is found subdivided into fasciculi, of which some pass over, some under

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* Dublin Hospital Reports, vol. v.

and between the vessels. In the bear and monkey, the whole of the tendon overlays the vein. When proceeding to expose the muscle, we may take advantage of the circumstance of its tendon coming forwards upon the root of the penis, a little anterior to the symphysis pubis. Trace back the dorsal vein, carefully divide the fibrous expansions of the suspensory ligament, draw the penis tightly forwards, and the tendon of the compressor will be brought into view by a little cautious dissection. Taking the tendon as a guide, trace the muscular fibres outwards and downwards, detaching at the same time the crus penis from the ramus for some way from above downwards. Having proceeded so far, cut through the pubic symphysis, saw through the ramus close above the fibres of the muscle, and the body of the bone about its middle, and remove it altogether. The muscle will be fully exposed. This plan will do very well in the dog, or in a fresh muscular subject; but if the fleshy fibres are pale, and those of the tendon discoloured, the mode pointed out by Mr. Houston * had better be adopted: "Detach the bladder and levator ani from one side of the pelvis; with a saw divide the pubis and ischium about an inch from the symphysis, and break the bones at the sacro-iliac articulation. Next dissect away carefully the remaining part of the pubis from the symphysis, periosteum, and crus, then the compressor will be exposed without difficulty."

The perinæal muscles in the female correspond so nearly with those of the male in their number, general conformation, and attachments, that it is unnecessary to treat particularly of more than two of them.

510. *m. Erector clitoridis* (depressor, Meckel) resembles the diminutive of the erector penis; it arises from the ramus of the os pubis, and is inserted into the body of the clitoris.

511. *m. Constrictor vaginæ* (perinæo-clitorius) resembles an orbicular muscle, being composed of two narrow fasciculi, united before and behind the vagina by two commissures, and leaving between them an elliptic interval corresponding with its circumference. The two muscles of this name may be said to arise posteriorly at a point which is common to them, to the sphincter ani and transversi muscles; after diverging to enclose the vagina,

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* Loc. cit.

they unite in front of it into a tendinous process, which connects them to the corpus clitoridis.

The anal muscles are as follow:—

512. *m. Sphincter ani externus*, fig. 110, 4, (coccygeo-analis,) is a flat elliptic muscle, placed immediately beneath the skin surrounding the margin of the anus. It is attached posteriorly to the coccyx by a narrow fasciculus of tendinous fibres, and anteriorly becomes blended, about midway between the anus and the bulb, through the medium of a common fibrous point, with the transversi and acceleratores muscles, whilst the intervening part is disposed like orbicular muscles elsewhere, being composed of fleshy fibres curving round the intestine, and united by commissures before and behind it. One surface of the muscle is covered by the skin, the other rests on the internal sphincter, and on some cellular tissue which separates it from the levator ani.

513. *m. Sphincter ani internus* is a flat muscular ring, surrounding the anal extremity of the rectum; it is about four or five lines in breadth, and two thick. It obviously consists of the circular fibres of the intestine much more developed than elsewhere, and projecting lower down than the longitudinal fibres.

514. *m. Levator ani*, fig. 110, 5, (sub-pubio-coccygeus,) is a thin broad muscle, placed obliquely across the outlet of the pelvis, which it assists in closing. Its origin cannot be distinctly stated without making reference to two membranes between which it is placed, and from whose line of union most of its fibres are derived. The obturator internus muscle occupies the whole space from the internal border of the obturator foramen to the sciatic notch. The upper half of this muscle is lined by the pelvic fascia, prolonged down as far as to a line extended from the symphysis pubis to the spine of the ischium, where it is reflected upon the levator ani, which guides it to the side of the rectum and bladder. The lower part of the obturator muscle is also covered by a fascia, but more dense and firm, which is prolonged upwards upon it from the edge of the falciform process of the great sacro-sciatic ligament, which is attached along the rami of the ischium and os pubis. This fascia becomes united to the fascia pelvica along the line above indicated, and may be said to determine its point of flexion; and from the

angle which they form by their union, arises the middle part of the levator ani. This fact may be easily ascertained by dividing the obturator fascia for an inch, or little more, and then passing a probe between it and the obturator muscle. It will then be found, as the instrument is being moved backwards and forwards, that the greater part of the levator ani is attached only to these membranes.

The *levator ani* then *arises*, anteriorly, from the os pubis, near its symphysis, and immediately above its arch; posteriorly, from the spine of the ischium, and along the intervening space from the angle formed by the union of the obturator and pelvic fasciæ. From this extensive origin the fibres proceed downwards and inwards, the posterior set being fixed to the side of the coccyx; those next them in order unite by a raphé with the corresponding muscle, in the interval between the coccyx and the margin of the anus; the middle fibres are inserted into the extremity of the rectum, becoming connected with those of the internal sphincter, and the anterior ones pass on the side of the prostate, some of them uniting with those of the corresponding muscle beneath the membranous part of the urethra. In the female, the fibres of this muscle, previously to reaching the rectum, descend by the vagina, and become intimately connected with it.

515. *m. Coccygeus* (ischio-coccygeus) is placed deeply at the back part of the outlet of the pelvis, which it assists to close, by being stretched from the spinous process of the ischium to the side of the sacrum and coccyx. It is made up of tendinous and fleshy fibres, forming a flat triangular plane, the apex of which is attached to the spine of the ischium, and the base to the border of the coccyx and lower part of the sacrum. The internal, or pelvic surface, supports the rectum; the external is covered by the sacro-sciatic ligaments.

Actions.—The transverse muscles conspire to fix the common point of attachment of the perinæal muscles, and so increase their power. The action of the sphincter ani is sufficiently obvious. The accelerator muscle, by surrounding the bulbous part of the urethra, and by the increased power it acquires from its many points of attachment, is enabled forcibly to propel any fluid that may be lodged within the canal in that situation. The levator ani, in position and direction, is opposed to the diaphragm, and as the latter forces down the intestines by its descent, the former, as its name implies, can elevate at least the lower part of the intestinal canal. The compressors of the dorsal vein have some analogy in form to the accelerator urinæ, for the muscles of opposite sides unite in the middle line and form a tube which surrounds the vein, as the fibres of the accelerator do the canal of the urethra. The name expresses their apparent use; they constrict the vein, and prevent the return of blood by it, so as to continue the distension of the parts during the venereal orgasm. The compressor urethræ supports the membranous part of the canal, as in a sling; it can also elevate it, and so, by drawing up the under surface, close it altogether.

Muscles of the Inferior Extremity.

ILIAC REGION.

In the iliac fossa, and along the upper border of the pelvis, we find placed the iliacus and psoas muscles. We need not give any particular directions for their dissection, as it is never undertaken until the abdominal muscles have been examined and the viscera removed, and then they are at once brought into view, being merely concealed by the fascia iliaca.

516. *m. Psoas magnus*, figs. 109, 3; 113, 1, (præ-lumbo-trochantineus,) is situated along the side of the lumbar vertebræ, the margin of the pelvis, and deeply at the superior part of the thigh, extending from the last dorsal vertebra to the small trochanter of the femur. Form—thick and round at the centre, diminishing in size towards the extremities. It *arises* from the sides of the bodies of the last dorsal and of the first four lumbar vertebræ, and the interposed fibro-cartilages, also from the roots of the transverse processes of the last-named vertebræ. From these attachments, which are separated by the branches of the lumbar plexus of nerves, the muscle passes across the brim of the pelvis, beneath Poupart's ligament, and ends in a tendon, which is inserted into the small trochanter of the femur. The direction of the muscle, in the greater part of its extent, is nearly vertical; it has, however, a slight inclination outwards—and its lower part passes backwards to reach its destination: structure—fleshy in the centre, tendinous at its insertion: relations—vary in the different parts of its extent: its posterior surface corresponds above with the transverse processes of the

lumbar vertebræ, the lumbar plexus of nerves, and the quadratus lumborum muscle, from which last it is separated by the anterior lamella of the aponeurosis of the transversalis muscle; in the middle, with the margin of the pelvis; farther down, with the os pubis and the capsular ligament of the hip-joint; the anterior surface, placed behind the peritonæum, is in relation above with the ligamentum arcuatum and diaphragm, the renal vessels and ureter, the sympathetic nerve and its ganglia; in the middle it is covered by the iliac fascia, farther down by the femoral artery which rests upon it; and, finally, by the deep-seated vessels of the groin, inguinal glands, &c. The inner border is in relation superiorly with the bodies of the vertebræ, from the middle of which it is separated by the lumbar arteries and branches of communication between the spinal and sympathetic nerves; in the pelvic region with the iliac artery; and in the femoral with the pectineus muscle, from which it is separated by the internal circumflex artery. Its outer border is in relation with the inner border of the iliacus muscle from which it is at first separated by a slight cellular interval, and then by the lumbar nerves.

517. *m. Psoas parvus*, fig. 113, 2, (præ-lumbo-pubius,) is situated (when it exists, which is not always the case) along the anterior side of the psoas magnus. Form—long and thin. It *arises* from the body of the last dorsal and first lumbar vertebra, and soon ends in a flat tendon, which passes along the anterior and inner side of the psoas magnus, to be inserted into the ilio-pectineal eminence. Direction—vertical: structure—muscular and tendinous: relations—it rests on the psoas magnus in the whole of its extent; and is covered by the fascia iliaca,—crossed at its origin by the diaphragm, and lower down by the renal vessels.

518. *m. Iliacus*, fig. 113, 3, (iliacus internus, Albinus, Sœmm.; ilio-trochantineus,) is situated in the iliac fossa, which it fills up, and at the upper and fore part of the thigh. Form—compressed and somewhat radiated. It *arises* from the upper two-thirds of the iliac fossa, from the anterior two-thirds of the inner margin of the crista ilii as far as its two spinous processes, and posteriorly from the ilio-lumbar ligament. From these different origins the fibres pass down, the greater number inclining obliquely inwards, to be inserted into the tendon com-

mon to this muscle and the psoas magnus, some of them being prolonged into the oblique line which leads downwards from the small trochanter. Structure—fleshy in almost all its extent: relations—posteriorly with the ilium and capsular ligament of the hip-joint, anteriorly with the iliac fascia, which separates it from the peritonæum, and by its inner border with the crural nerve and psoas muscle; it is subjacent to the cœcum at the right side, and to the sigmoid flexure of the colon on the left. This muscle is even still called iliacus internus, though there is now no correlative term in use, no muscle being called iliacus externus. Cowper, and some of the older anatomists, called the pyriformis by that name.

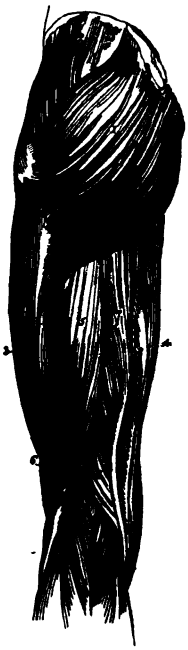
Combined actions.—The psoas and iliacus, when they take their fixed point above, can bend the thigh on the pelvis, and rotate the limb somewhat outwards,—the latter power being derived from the direction of their common tendon and the mechanical advantage given them by the projection of the trochanter minor. These muscles assist materially in maintaining the erect position of the body, in which case they take their fixed point at their insertion into the femur, and then act upon the pelvis and spinal column, drawing them forwards so as to keep them erect upon the thighs. If this action be continued, the trunk may be bent forwards as in bowing. It is scarcely necessary to add, that this bending of the body will be directly forwards if the muscles of opposite sides act together, and obliquely to one side if they act separately.

GLUTEAL REGION.

519. In this space, which comprehends the posterior and external surface of the pelvis, we find the glutei, and the external rotator muscles of the thigh.

Dissection.—The subject being placed in the prone position, and the abdomen supported on a high block, the foot should be rotated inwards, and the limb abducted, in order to put the gluteus on the stretch. An incision may be made through the skin, from the coccyx obliquely upwards over the side of the sacrum and posterior spine of the ilium, and as high as its crista; from which point draw another obliquely downwards over the great trochanter. The flap thus included should be dissected cleanly off the muscle in the course of its fibres, that is to say, downwards and outwards. The remainder of the skin which covers the pelvis may be reflected upwards and outwards, the fascia serving as a guide. This will expose the tensor vaginæ and part of the gluteus medius. The rest of the latter can be seen only when the gluteus maximus is detached. To effect this, let its lower border be drawn a little forwards, and the scalpel be inserted beneath it, so as to raise it from the sciatic ligament, and so successively from the side of the coccyx, sacrum, and ilium, proceeding from below upwards. When the muscle is detached, and turned down on the femur, the external rotators and gluteus medius come into view, and require little further dissection. As the gluteus medius covers the third muscle of that name, the easiest mode of reflecting it is by cutting through its tendinous insertion, and drawing it upwards. The external rotators should be attentively examined, more particularly the two obturator muscles. The internal one cannot be fully seen until the pelvis is divided; but the direction of its two parts, and the peculiar appearance presented by its tendon, where it slides over the ischium, can be observed by cutting it across near its insertion, and reflecting it outwards.

Fig. 111.

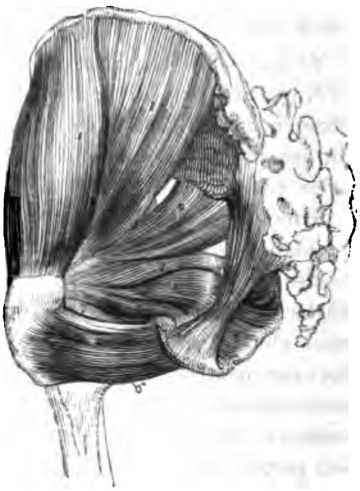


520. *m. Gluteus maximus*, fig. 111, 1, (ilio-sacro-femoralis,) is situated behind the pelvis, at the nates, the prominence of which it forms. It extends from the back part of the ilium, the sacrum, and the coccyx, to the rough ridge at the upper and back part of the femur beneath the great trochanter. Form—broad, thick, and irregularly quadrilateral. It *arises*, 1, from the posterior fifth of the crista of the ilium, and the irregular rough surface subjacent to that part; 2, from the posterior surface of the sacrum below the ilium, and from the side of the coccyx in its whole length; 3, from the posterior or great sacro-sciatic ligament. From these origins, the coarse thick fibres of which the muscle consists converge as they pass downwards and outwards, and terminate in a broad strong tendon, whose external surface is rough and irregular, but the internal is smooth, and lined by a bursa mucosa, where it

corresponds with the great trochanter. This tendon is ***inserted***, between the vastus externus and adductor magnus, into that rough longitudinal impression which descends from a little way beneath the great trochanter to the linea aspera. Direction—downwards, forwards, and outwards : structure—aponeurotic along its line of origin, tendinous at its insertion, fleshy in by far the greatest part of its extent. The fibres of origin are blended with those of the aponeurosis of the sacro-lumbalis and latissimus dorsi. The fleshy fibres are thick and coarse, those at the anterior border are shorter than those in the middle, and the latter than those along the posterior border. The fleshy fibres, which immediately succeed to the aponeurotic attachments superiorly, are arranged in parallel lines and aggregated into large distinct bundles, separated by cellular membrane. These fleshy bundles successively terminate at the posterior border of a strong common tendon, which extends from opposite the upper part of the great trochanter, where it is broad, and confounded with the fascia lata, to the line of attachment just described. Relations—the external surface is covered by the fascia lata, which here is very thin; the upper and anterior border is firmly connected by that membrane with the gluteus medius; the posterior is on the same plane, and somewhat identified with the common origin of the sacro-lumbalis and longissimus dorsi muscles; the inferior border (the longest) is free, and forms the fold of the nates. When the muscle is separated from its superior connexions and reflected downwards, it will be found that its inner surface covers, and is therefore in relation with, the ilium, sacrum, and coccyx, the great sciatic ligament, the gluteus medius, the gluteal, sciatic, and pudic vessels, the external rotator muscles, the great sciatic nerve, the trochanter major, the tuberosity of the ischium, and the superior extremities of the semitendinosus and biceps muscles.

521. *m. Gluteus medius*, fig. 111, 2; fig. 112, 1, (ilio-trochantereus major,) is situated on the external surface of the pelvis, partly covered by the preceding muscle, partly by the skin and fascia. It is broad, and, as it were, radiating at its upper part, but narrow and thick at its lower extremity. It ***arises*** by short aponeurotic fibres from the anterior four-fifths of the crista ilii, (its outer margin,)—from the rough line which bounds the surface on the back part of

Fig. 112.



the ilium whence the gluteus maximus arises,—from that part of the external surface of the ilium which extends from the crista ilii, and the line just named, down to the superior curved line, also from the latter. From this extensive origin the fleshy fibres as they descend converge to a short thick tendon, which is blended anteriorly with that of the gluteus minimus, and posteriorly, in many instances, with the pyriformis; after which its fibres are inserted into the broad external surface of the trochanter major, and somewhat into its upper border. Direction—the anterior fibres extend obliquely backwards, the posterior obliquely forwards, the middle perpendicularly: structure—tendinous at the inferior attachment, fleshy in the rest of its extent: relations—part of the external surface is covered by the gluteus maximus, the rest by the fascia lata; the inner surface rests on the ilium, the gluteus minimus, and the branches of the gluteal vessels; the posterior border is in relation with the pyriformis muscle; the anterior is intimately connected with the tensor vaginæ femoris, by means of the fascia lata.

522. *m. Gluteus minimus* (ilio-trochantereus minor) is situated on the inferior part of the dorsum ilii. Form—radiated, broad above, narrow below. It *arises* from all that space on the dorsum ilii between the superior curved line and the inferior one, which runs above the brim of the acetabulum. From this origin the fibres converge as they descend, and end in a short tendon, which is *inserted* into the anterior border, and somewhat into the external surface of the great trochanter, where it is blended with that of the gluteus medius. Direction—the middle fibres are vertical, the anterior are inclined backwards, the posterior forwards, converging to the common tendon: structure—fleshy in the greater part of its extent, tendinous at its insertion: relations—by its external surface with the gluteus

medius; by the internal with the dorsum ilii, with the external tendon of the rectus femoris, and with the fibrous capsule of the hip-joint.

Actions.—The glutei act alternately on the femur and pelvis, according as the one or the other becomes relatively their fixed point of attachment. All three act as abductors; the anterior fibres of the gluteus medius and minimus draw the trochanter forwards, the posterior backwards, giving it a slight rotatory motion. The gluteus maximus is a powerful abductor, and by the direction of its fibres is calculated to draw the femur backwards, at the same time that it rotates the whole limb outwards if it be kept extended. When the thighs become the fixed points, these muscles act on the pelvis. The great glutei draw it backwards, and maintain it and the body in the erect position; in this they are assisted by the semi-tendinosus, semi-membranosus, and biceps of each side, which act on the tuberosities of the ischia, and draw them downwards, so as to elevate the fore part of the pelvis. The gluteus medius and minimus are chiefly called into action in progression, and in standing on one leg; they draw the pelvis towards the femur, which is fixed, and by this action counterbalance the weight of the trunk, and maintain it erect on the limb. This alternation of action of the muscles of opposite sides during progression, gives to the pelvis that rotatory motion so perceptible in those who walk irregularly, and which is strikingly evident in females, in consequence of the great breadth of the pelvis.

The external rotator muscles form a group by themselves, being placed deeply at the back of the pelvis. They are the pyriformis, two gemelli, two obturators, and quadratus femoris.

Dissection.—Most of these are exposed by the removal of the gluteus maximus. The origin of the obturator internus cannot be seen until the pelvis is opened.

523. *m. Pyriformis*, fig. 112, 2, (pyramidalis, sacro-trochantereus,) is situated at first within the pelvis, and afterwards on its posterior and external surface, extending from the anterior surface of the sacrum through the great sacro-sciatic notch to the great trochanter of the femur. Form—elongated and tapering, as its name imports. It *arises*, by three fleshy and tendinous digitations, from the second, third, and fourth divisions of the sacrum, interposed as it were between the anterior sacral foramina; a few fibres are also connected with the inner surface

of the ilium, near its lower curved border. From these attachments the muscle passes out of the pelvis by the great sacrosciatic notch, and is *inserted* into the posterior border of the great trochanter by a rounded tendon, whose fibres are blended somewhat with those of the gluteus medius. Direction—downwards and outwards: structure—fleshy and tendinous: relations—within the pelvis it is placed behind the sciatic plexus of nerves, the internal iliac vessels, and the rectum (the last more especially at the left side). Outside the pelvis one surface rests on the ischium and the fibrous capsule of the hip-joint, the other is covered by the gluteus maximus; its superior border is parallel with the gluteus medius, from which it is separated by the gluteal vessels as they emerge from the pelvis, the inferior is a little above the gemellus superior and crosses the great sciatic nerve. The separation always existing at its points of origin sometimes continues to be apparent even after the muscle has passed out by the pelvis: when this is the case, the interval gives passage to one of the divisions of the great sciatic nerve.

524. *m. Gemelli* (ischio-trochanterei) are two small narrow fasciculi stretched nearly in the horizontal direction from the spinous process of the ischium and its tuberosity to the trochanteric fossa. They are named, from their position, superior and inferior, the latter being the larger. The superior one, fig. 112, 3, *arises* from the spinous process of the ischium; the inferior, 4, from the upper and back part of the tuberosity of that bone; and both are *inserted* into the digital or trochanteric fossa, together with the tendon of the obturator internus, which they enclose and almost conceal. Direction—transversely outwards from the ischium to the trochanter: structure—tendinous at their insertion, fleshy in the rest of their extent: relations—their posterior surface is crossed by the sciatic nerve, and covered by the gluteus maximus muscle; the anterior surface rests on the ischium and fibrous capsule of the hip-joint; the smaller gemellus corresponds by its upper border with the pyriformis; the larger by its lower border with the tendon of the obturator externus, the contiguous borders of each being intimately connected with the tendon of the obturator internus, which runs between them.

525. *m. Obturator internus*, fig. 112, 5, (sub-pubio-trochan-

tereus,) is situated chiefly within the pelvis, a small part only being placed on its external surface. Form—flat and triangular. It *arises* by tendinous and fleshy fibres from the inner flat surface of the os pubis, extending from near its symphysis as far as the margin of the obturator foramen,—from the obturator membrane, except where it is pierced for the transmission of the obturator vessels,—and from the inner flat surface of the ischium as far back as the sciatic notch, on a level with a line drawn from the upper margin of the obturator foramen backwards to that of the notch. The fibres converge to a tendon, which passes out of the pelvis by the inferior sciatic notch, and is inserted into the trochanteric fossa between the gemelli muscles. Direction—it at first passes backwards, then is reflected over a pulley-like surface on the ischium, situated between the spine and tuberosity of that bone, after which it proceeds horizontally outwards, so that the internal and external portions form a considerable angle with one another: structure—fleshy whilst within the pelvis; its tendon, flat and uniform on its posterior surface, presents at its anterior aspect four small tendinous bundles, which slide upon the smooth surface of the ischium above noticed: relations—within the pelvis it is covered by the internal pudic artery and the obturator fascia, which separates it from the levator ani muscle; its tendon lies on the ischium and fibrous capsule of the hip-joint, being covered by the great sciatic nerve and gluteus maximus muscle; its borders are enclosed between the gemelli.

526. *m. Quadratus femoris*, fig. 112, 6, (tuber-ischio-trochantereus,) is placed deeply at the upper and back part of the thigh, extending from the external margin of the tuber ischii outwards to the posterior border of the great trochanter. It is short and flat, its form being that of an oblong square. It *arises* from the external curved border of the tuber ischii, and is *inserted* into the lower half of the posterior border of the great trochanter; its middle corresponding with a smooth rising or tuberosity observable in that border. The line of insertion of this muscle may properly be called *linea quadrati*, to distinguish it from the inter-trochanteric line, the latter being oblique in its direction, the former vertical. Direction—horizontally outwards: structure—fleshy and very slightly tendinous at its attachments, fleshy in the rest of its extent: relations—by its posterior sur-

face, with the great sciatic nerve, the gluteus maximus and semi-membranosus muscles; by the anterior, with the obturator externus, the lesser trochanter, and part of the insertion of the psoas magnus muscle; its upper border is in relation with the inferior gemellus, the lower with the adductor magnus.

527. *m. Obturator externus*, fig. 112, 7, (sub-pubio-trochantereus externus,) is situated deeply at the anterior and external aspect of the pelvis, and superior part of the thigh. Form—flat and triangular. It *arises* from the external flat surface of the os pubis,—from the rami of the os pubis and ischium, as far as the margin of the obturator foramen, and from about half the surface of the obturator membrane. From this extensive origin the fibres pass outwards, converging to a tendon, which is directed behind the neck of the femur, to be *inserted* into the lower part of the trochanteric fossa, beneath the inferior gemellus. Direction—obliquely outwards, winding round the posterior part of the neck of the femur: structure—tendinous at its insertion, fleshy in the greater part of its extent, with a slight mixture of aponeurotic fibres at its origin: relations—its anterior surface, which in the erect position of the body is also the inferior one, is covered by the adductor brevis and pectineus muscles, also by the obturator vessels; the posterior one corresponds with the os pubis, its ramus, and that of the ischium, as well as the obturator membrane; one surface of its tendon is in close contact with the fibrous capsule of the hip-joint, the other is covered by the quadratus femoris.

Actions.—The transverse direction of these muscles, and their mode of insertion into the trochanter, together with the great mechanical advantage afforded them by the length of the cervix femoris, enables them to act powerfully in rotating the thigh, and therefore the whole limb, outwards. In position, direction, and action, they are analogous to the muscles which pass from the dorsum of the scapula to the great tuberosity of the humerus; the latter, however, are nearly equalled in strength by their antagonist, the sub-scapularis; but the external rotators of the thigh are very feebly opposed by the tensor vaginæ femoris, and the anterior fibres of the gluteus medius, which alone act directly in rotating the limb inwards, if we except the semi-tendinosus, which may, under some circumstances, co-operate in this action. If the femur be bent on the pelvis, the line of direction of these muscles nearly coincides with the axis of the bone; their power of rotation then ceases, but they may in a slight degree become abductors; at least this may be said of the pyriformis, both from its direction and point of insertion.

ANTERIOR FEMORAL REGION.

528. At the fore part of the thigh we find, immediately beneath the skin and fascia, these muscles, viz. the tensor vaginæ femoris, sartorius, rectus, vastus externus and internus, crureus.

Dissection.—To expose the fascia lata:—In the first place, let the knee be slightly bent,—the limb rotated outwards and supported on a block. And, as in this position the course of the femoral artery is indicated by a line extended from midway between the anterior superior spine of the ilium and the pubic symphysis to the lower border of the patella, the first incision through the skin should be made to the same extent, and in the same direction. In order to reflect the integuments with facility, a second incision may be made transversely at the junction of the upper with the middle third of the thigh; and finally, another in the same direction at the junction of the middle with the lower third; this marks the termination of the femoral artery. The flaps of skin thus formed are to be dissected back, so as to expose the fascia lata. This membranous investment should be attentively examined in its entire extent, particularly at the upper part; the differences of texture and thickness which it presents in different parts should also be carefully noted.

To expose the muscles:—In prosecuting the dissection, in order to expose the muscles on the fore part of the thigh (and it is with these the dissection usually commences), nothing more is necessary, after the skin has been removed, than to pinch up the fascia with the blades of the forceps, divide it with your scalpel, and reflect it from above downwards, in the direction of the fibres of each muscle. After the sartorius and rectus have been dissected in their entire length, and their attachments and relations attentively examined, the former may be cut across in the middle, and the parts drawn aside; the latter too may be divided near its origin, and turned down on the leg. The triceps extensor is thus brought fully into view, so that its three parts (the two vasti and the crureus) may be inspected successively, at the same time that it is considered as a whole. The muscle in fact may be compared to a hollow splint, encasing the anterior and lateral surfaces of the shaft of the femur, leaving unoccupied only the linea aspera and its bifurcations (superior and inferior.)

To detach the vasti:—A perpendicular incision may, in the next place, be made through the muscle, extending from one extremity to the other over the middle of the femur. If the margins of the incision be drawn aside, a clear view will be obtained of the manner in which the fibres pass to be implanted, by so many separate points, into the surface of the bone. Holding the border of the incision tense, and with the blade of the scalpel placed in the horizontal position, the muscle may be detached from the bone inwards as far as the insertion of the adductors, and outwards to the attachment of the gluteus maximus, and the short head of the biceps, so as to denude the front and sides of the thigh-bone. Having proceeded so far, cut from within outwards through the vasti, so as to detach them altogether. When this is done, the two parts thus separated may be turned down on the leg, still left connected with the patella.

By these measures we shall bring into view the inferior attachments of the next set of muscles (adductors), which would otherwise lie in a great degree concealed.

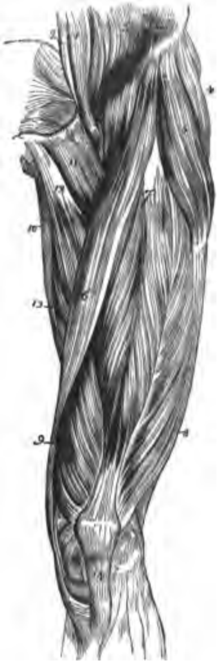
Before the extensors are detached and reflected, the form and boundaries of the opening for the femoral vessels should be attentively examined, as the vastus internus constitutes a part of it; nor should the fascia be omitted which passes from the latter muscle to the adductors, covering the vessels.

529. *m. Tensor vaginæ femoris*, fig. 113, 5, (ilio-aponeurosi-femoralis,) is situated at the upper and outer part of the thigh, extending obliquely downwards, outwards and backwards, from the anterior superior spinous process of the ilium to about three inches below the great trochanter. Form—elongated and flat, broader at the lower than at the upper extremity. It *arises* from the external surface of the anterior superior spinous process of the ilium, between the gluteus medius, 4, and the sartorius, 6, and terminates about three inches below the great trochanter of the femur, its fleshy fibres being received between two laminæ of the fascia lata, into which they are thus inserted. Direction—as above stated: structure—aponeurotic in its origin, fleshy in the rest of its extent: relations—its external surface is covered by a layer of the fascia lata; the internal is also embraced by another process of the same membrane, which separates it from the rectus femoris and the vastus externus. Its anterior border is at first close to the sartorius, but lower down diverges and leaves an angular interval occupied by the rectus

femoris. Its posterior border is for some way applied to the gluteus medius, but lower down they are separated by an interval.

Actions. As its name imports, the direct action of this muscle is to render the fascia tense, and thereby assist the other muscles. If this effort be farther continued, the obliquity of its direction will enable it to rotate the whole limb inwards, provided the other muscles remain quiescent. In the erect position, by taking its fixed point below, it will act on the pelvis.

Fig. 113.



530. *m. Sartorius*, fig. 113, 6, (ilio-præ-tibialis,) is situated at the anterior and inner aspect of the thigh ; it is a long, flat, narrow muscle, which extends from the anterior superior spinous process of the ilium down to the inner and fore part of the tibia. It *arises* from the curved margin of the ilium, between its anterior superior and inferior spinous processes, and from the former point of bone, and is *inserted* by an expanded aponeurosis into the upper and inner side of the tibia, just below its tuberosity. Direction—obliquely downwards and inwards in the upper third of its extent, then vertical as far as the knee, where it turns obliquely forwards to its point of attachment : structure—fleshy, except at the extremities, which are tendinous. The inferior tendon, broad and expanded, covers those of the gracilis and semi-tendinosus, and sends off an expansion which strengthens the fascia of the leg, by becoming identified with it. Relations—by the anterior surface with the fascia lata ; by the posterior, with the iliacus, psoas, and rectus femoris muscles, the femoral vessels, the adductor longus, adductor magnus, vastus internus, gracilis, and semi-tendinosus muscles. Its internal border bounds, with the adductor longus, a triangular space in the upper third of the thigh, through the centre and apex of which the femoral artery passes.

531. m. *Rectus femoris*, fig. 113, 7, (ilio-rotuleus,) is situated in front of the thigh, being extended in a straight line from the pelvis to the patella. Form—elongated, smaller at the extremities than in the middle. It *arises* by two tendons, one of which embraces the anterior inferior spinous process of the ilium; the other, reflected outwards, is attached along the brim of the acetabulum. The tendons unite at an angle; from their union the muscle descends, gradually increasing in breadth and thickness towards its middle, from which it diminishes again towards its lower part. It is *inserted* into the patella, in conjunction with the triceps extensor. Direction—vertical: structure—fleshy and tendinous at the extremities, fleshy at the middle part or belly, which, though compressed somewhat from before backwards, swells out at the sides so as to assume a fusiform or tapering appearance. The muscular fibres are disposed in two sets, united at acute angles along the middle line, from which they pass off obliquely, diverging to the borders. From this arrangement, which resembles that of the lateral fibrillæ of a quill or feather, the muscle is said to be penniform. The fibres of the superior tendon run down a considerable way on the fore part of the muscle; those of the inferior tendon are prolonged upon its posterior aspect. This arrangement is calculated, in the former case, to facilitate the movement of the sartorius upon the rectus—in the latter, that of the rectus itself upon the crureus. Relations—the anterior surface is covered in all its extent by the fascia lata, except a small portion superiorly, where it is overlaid by the tensor vaginæ, iliacus, and sartorius muscles (the reflected tendon is covered by the gluteus minimus); by the posterior surface it is in relation with the fibrous capsule of the hip-joint and the triceps extensor muscle, upon which it rests: its borders are free and unattached in the greater part of their extent, but inferiorly they become united with the two vasti, between which it lies.

532. m. *Triceps extensor cruris* (tri-femoro-rotuleus) is a considerable mass of muscle which encircles all the body of the femur, except the linea aspera and the spaces between its bifurcations. Superiorly, it presents three portions or heads, whence its name; inferiorly, these are attached by a common tendon to the patella, which we shall consider as their common origin. This tendon, at first confounded with that of the rectus muscle,

soon separates from it, and, ascending a little way on the femur, gives off three processes, corresponding with the three divisions of the muscle, viz. the vastus externus, the vastus internus, and crureus; from the tendon, moreover, a fascia or aponeurosis is sent down over the knee-joint, which strengthens the articulation, and is inserted into the head of the tibia. Each of these parts of the triceps is usually described as a distinct muscle.

533. *m. Vastus externus*, fig. 113, 8 ; fig. 111, 3, is situated on the outside of the femur, larger above and in the centre than below ; its fleshy fibres *arise* from the outer side of the common tendon, and pass to their insertion with varying degrees of obliquity. The inferior fibres pass almost transversely outwards, to about the middle of the line leading from the outer condyle of the femur to the linea aspera ; those higher up are inserted into the external margin of the linea aspera and its superior bifurcation ; the rest are implanted into the external surface of the bone, as far as the base of the great trochanter. Direction—the lower fibres are transverse, the rest oblique: structure—fleshy and aponeurotic: relations—anteriorly, with the fascia lata; posteriorly, with the femur; its external border is in apposition with the short head of the biceps and the gluteus maximus; the internal with the crureus, with whose structure it is identified.

534. *m. Vastus internus*, fig. 113, 9, is situated on the inner side of the femur. Form—elongated, broader below than above. It *arises* from the inner side of the common tendon, from which its fibres, like those of the preceding muscle, pass obliquely to their insertion; the inferior fibres terminate above the middle of the oblique line leading from the inner condyle to the linea aspera; those higher up are implanted into the inner margin of the linea aspera itself, the rest being inserted into the surface of the bone, as far as the base of the lesser trochanter. Direction—the lower fibres run almost transversely; the rest obliquely, upwards and inwards: structure—fleshy and aponeurotic: relations—by its anterior and inner surface with the fascia lata, the sartorius, and femoral vessels; the posterior surface rests on the femur; the inner border is in contact with the adductor magnus, longus, pectineus, and psoas muscles; the external is blended with the crureus.

535. *m. Crureus* is situated along the middle of the anterior

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] than to remove the inner and [illegible] The direction and attachments of the adductor longus, running obliquely from the angle of the os pubis to the middle of the thigh, are at once obvious. The gracilis, too, will be observed running along its inner border. If the thigh be abducted, the fibres of these muscles will be rendered tense, and their dissection facilitated.

When proceeding with the dissection, the adductor longus may be severed from its superior attachment, and drawn downwards on the femur. In doing this, its posterior surface will be observed to be connected to the adductor magnus for a little way before their fibres reach the bone. The pectineus, lying to the outer side of the adductor, may in the next place be examined, and reflected after the same manner, which will bring into view the adductor brevis and the obturator externus.

Whilst these measures are being executed, both surfaces of each muscle should be dissected, or, in other words, all the cellular tissue connected with them should be removed by successive strokes of the knife, the edge being carried in the course of the fibres; and when their attachments, external conformation, and structure have been thus fully made out, each of them may be again restored to its place, that their mutual relations and bearings may be reconsidered. It is usual to direct that muscles, more especially the long ones, should be divided in the centre, and the two portions reflected. But if this precept be followed, it will be observed that students seldom examine, with any degree of accuracy, the points of attachment of muscles, without a precise knowledge of which it is quite impossible to reason correctly on their actions and uses. When a student is performing the dissection of the limb for the first time, it may be well if he confine his attention to the muscles, observing merely the general outline of the vessels and their branches; after which they may all be dissected away, in order to obtain an uninterrupted view of the muscles in their whole extent.

537. *m. Gracilis*, fig. 113, 10; fig. 111, 4, (pubio-præ-tibialis,) is situated along the inner border of the thigh, extending from the os pubis and its ramus to the inner and upper part of the tibia. It is flat and thin; broad at its upper extremity, narrow and tapering at the lower. It *arises* by a thin aponeurosis from the body of the os pubis, close to its symphysis (the lower half of its depth), also from the border of its ramus, and is *inserted* by a tendon (which is at first round, but afterwards becomes flat) into the inner side of the tibia, close below its

tuberosity, on the same plane with the semi-tendinosus, and under the expanded tendon of the sartorius. Direction—vertical; at the lower extremity it inclines a little forwards to the point of attachment: structure—aponeurotic superiorly, tendinous in the inferior third, and fleshy in the rest of its extent: relations—its inner surface is covered by the fascia lata, except a small part inferiorly, where it is overlapped by the sartorius; the external rests against the adductor longus, magnus, and semi-membranosus, the knee-joint, and its internal lateral ligament.

538. *m. Pectineus*, fig. 113, 11, (pectinalis; pubio-femoralis,) is situated at the superior and fore part of the thigh, being extended from the body of the os pubis (its upper surface) to the oblique line below the small trochanter. Form—flat and nearly triangular. It *arises* from the ilio-pectineal line, between the eminence of the same name and the spine of the os pubis, and is *inserted* into the line which connects the smaller trochanter to the linea aspera of the femur, immediately below the united attachment of the psoas and iliacus muscles. Direction—downwards, outwards, and backwards; opposite the smaller trochanter it turns on itself, so that the anterior surface looks somewhat outwards: structure—fleshy, except at the attachments, which are aponeurotic: relations—by the anterior surface, with the fascia lata and femoral vessels; by the posterior surface, with the obturator vessels and nerves, and the external obturator and adductor brevis muscles; by the outer border with the psoas magnus, by the inner border with the adductor longus.

539. *m. Adductor longus*, fig. 113, 12, (adductor primus; pubio-femoralis,) is situated at the superior and inner part of the thigh. It is flat, irregularly triangular, and extends obliquely from the body of the os pubis (its inner extremity) to the middle of the linea aspera of the femur. It *arises* from the external surface of the angle of the pubes, between its spine and symphysis, and is *inserted* into the middle third of the linea aspera, between the vastus internus and the adductor magnus; its direction between these points being downwards, outwards, and backwards: structure—tendinous at its origin, fleshy in the middle, aponeurotic inferiorly. From the aponeurosis several fibres are detached, which unite with those of the adductor magnus: relations—its anterior surface is covered by

the fascia lata, the sartorius, and femoral vessels; the posterior rests on the two other adductor muscles. The external border is parallel with the pectineus (a small portion of the adductor brevis being observable behind and between them); the inner border, which is much the longest, is in apposition with the gracilis.

540. *m. Adductor brevis* (adductor secundus; sub-pubio-femoralis) is situated rather deeply at the upper and inner part of the thigh. Form—nearly triangular, being thick and narrow at its upper part, but gradually becoming broader and thinner towards its insertion. It *arises* by a narrow origin, beneath the preceding muscle, from the external surface of the os pubis, and is *inserted* into the oblique line leading from the base of the lesser trochanter of the femur to the linea aspera, immediately behind the insertion of the pectineus. Direction—outwards, downwards, and a little backwards: structure—fleshy, except at its attachments, which are somewhat aponeurotic: relations—by the anterior surface, with the pectineus and adductor longus; by the posterior, with the adductor magnus; by the external border, with the obturator externus, and the tendon of the psoas and iliacus; by the inner border, with the gracilis in part of its extent, the rest being concealed between the two other adductors. This muscle is pierced by some of the perforating branches of the profunda artery.

541. *m. Adductor magnus* (ischio-femoralis) is situated deeply at the posterior and inner part of the thigh; hence but a few of its fibres, 13, can be seen in this view:—It extends from the tuberosity and ramus of the ischium to the whole length of the linea aspera of the femur, and to its inner condyle. It *arises* from the ramus of the os pubis and that of the ischium, also from the border of the tuberosity of the latter bone. The muscular fibres diverge from their origin, somewhat like the ribs of a fan from their central pivot; those from the os pubis, shorter than the rest, pass transversely outwards, and are inserted into the rough line prolonged from the linea aspera directly upwards; others pass with varying degrees of obliquity downwards and outwards, to be inserted into the whole length of the linea aspera, and a small part of its internal bifurcation, where they end in a pointed process; finally, some of the fibres descend almost vertically, forming the inner border of the muscle, and terminate in

a rounded tendon, which is inserted into the tuberosity on the inner condyle of the femur. The muscle thus presents two parts; one a flat broad plane, inserted into the linea aspera, and forming a septum between the anterior and posterior muscles of the thigh; the other being the elongated part which goes to the condyle. Between these an angular interval is left for the transmission of the femoral vessels backwards into the popliteal space. Direction—the fibres pass obliquely from within outwards and downwards, radiating as from a common centre: structure—fleshy in the greater part of its extent, aponeurotic where it arises from the ischium, and tendinous where it is inserted into the condyle: relations—the superior, or shortest border, is parallel and on the same plane with the quadratus femoris; the internal, or longest border, is covered by the fascia lata, the gracilis, and sartorius; the external border (its femoral attachment) is interposed between the two other adductors and the vastus internus, which lie in front of it, and the gluteus maximus, and short head of the biceps, which separate it from the vastus externus. The posterior surface is covered by the great sciatic nerve and ham-string muscles; the anterior by the sartorius, the adductor brevis and longus, and the femoral vessels. The anterior surface of the muscle is intimately blended with the adductor longus before it reaches its insertion; it also sends off an aponeurosis, which passes in front of the femoral vessels, and becomes blended with the vastus internus; finally, its prolonged portion is intimately connected with the last-named muscle. The interval left between the two parts of this muscle for the passage of the femoral vessels is triangular in its form, and fleshy and tendinous in its structure, when viewed from behind; but at its anterior aspect it is altogether tendinous in its entire extent, and oval in its form, its margins being formed of the following parts, viz. the prolonged tendon of the adductor magnus internally, the vastus internus externally, the superior border corresponding with the conjunction of the adductor longus and magnus; the inferior with the point of union between the prolonged tendon of the last-named muscle and the vastus internus.

Actions.—These are the direct adductors of the femur, and their force must be considerable, both from their strength and number. As the linea aspera projects from the shaft of the bone, the adductors are removed proportionally from its axis, and so are enabled to rotate it outwards, thus conspiring with a distinct class of muscles, the external rotators. If the whole limb be in the extended position, they will draw it inwards, the gracilis assisting. The femur is bent on the pelvis by the action of the pectineus (and slightly by the adductor longus and brevis), thus conspiring with the psoas and iliacus. When the lower extremities are firmly fixed on the ground, these muscles contribute to maintain the body in the erect position, by taking their fixed point below,, and thence acting on the pelvis. If this effort be continued, the pectineus and adductor longus may be made to flex the pelvis on the femur, by drawing the os pubis downwards.

POSTERIOR FEMORAL REGION.

542. At the back of the thigh are placed the three long flexor muscles of the leg, viz. the biceps, semi-tendinosus, and semi-membranosus. They are immediately subjacent to the skin and fascia, except at their superior attachment.

The *dissection* of this group should follow that of the muscles in the gluteal region, the subject continuing in the position indicated in sect. 519. From the middle of the incision made along the fold of the nates, or, what will answer just as well, from opposite the middle point between the tuber ischii and the great trochanter, carry an incision through the skin straight down along the back of the thigh and popliteal space, so as to mark out the median line of both. Let this extend to about three inches below the flexure of the knee-joint, and be there bounded by a transverse incision five or six inches in length. Make a similar transverse incision at the union of the middle with the lower third of the thigh. Now with your forceps pinch up the angles of these flaps of skin, and carefully dissect them off the subjacent fascia, which you will recognise as a smooth shining membrane. Examine this carefully in its whole extent. At the lower part of the thigh you will see it stretched tightly across from side to side, covering an angular space (popliteal space, or the ham in popular language), enclosed by the flexor or ham-string muscles, viz. those which you are now about to examine. Make an incision through the fascia from above downwards, along the middle of this space; bound it above and below by two transverse cuts. Pinch up the flaps of fascia tightly, and dissect them off the muscles, and so proceed downwards to their insertion into the tibia and fibula: continue the same process upwards, until you expose the muscles in their entire extent.

The origin of the flexors from the tuber ischii may be readily defined; and when their respective insertions are made out, that of the semi-membranosus should be particularly attended to, as it is attached to three distinct points. To gain a clear view of these attachments, the muscle may be cut across in the ham and drawn down, when, by holding it tense, one set of fibres will be observed to pass along the inner tuberosity of the tibia, another obliquely behind the joint, whilst the third goes perpendicularly downwards, which, after being fixed to the posterior surface of the tuberosity of the tibia, sends a dense fascia over the popliteus muscle, which is ultimately continuous with the deep fascia of the leg.

543. m. *Biceps femoris* (biceps flexor cruris; ischio-femoro-peronealis) is situated at the posterior part of the thigh. Form —elongated, divided above into two portions, or heads, of which one, the ischiadic, is long and rounded; the other, femoral, flat, and somewhat shorter. The long head, fig. 111, 5, *arises* by a tendon common to it and the semi-tendinosus from the upper and back part of the tuberosity of the ischium,—the femoral portion, 6, (or short head,) from the linea aspera of the femur, between the adductor magnus and vastus externus muscle, nearly as high up as the insertion of the gluteus maximus. These two parts, having united and become tendinous, are *inserted* into the head of the fibula: the tendon, whilst being attached, separates into two portions, which embrace the external lateral ligament of the knee-joint. One of these passes forwards upon the articulation of the fibula with the tibia: from the other an expansion is given off, which strengthens the fascia of the leg. Direction—vertical: relations—posteriorly with the gluteus maximus and fascia lata; in front with the semi-membranosus muscle, the sciatic nerve, and adductor magnus; inferiorly with the gastrocnemius externus, and external articular arteries.

544. m. *Semi-tendinosus*, fig. 111, 7, (ischio-præ-tibialis,) is situated at the posterior and inner part of the thigh. Form—elongated. It *arises* from the posterior part of the tuber ischii, close to the inner side of the biceps, and continues to arise from the tendon of that muscle for three inches lower down, somewhat in the same way as the coraco-brachialis does from the

biceps of the arm. A little below the middle of the thigh it ends in a long round tendon, which, passing along the inner side of the popliteal space, is reflected forwards, to be inserted into the inside of the upper part of the tibia, about two inches below its tuberosity, where the tendon is on the same plane, and beneath that of the gracilis. Direction — nearly vertical: structure—as its name implies, fleshy in half its extent, tendinous in the rest: relations—its posterior surface, except where it is slightly overlapped by the biceps, is covered by the fascia lata; the anterior surface rests on the semi-membranosus in the greater part of its extent; towards its termination, it runs beside the knee-joint; its insertion is covered by that of the sartorius.

545. m. *Semi-membranosus*, fig. 111, 8, (ischio-poplito-tibialis,) is situated obliquely at the posterior and inner part of the thigh. It *arises* from the posterior part of the tuberosity of the ischium, in front of the biceps and semi-tendinosus and behind the quadratus femoris, and is inserted by three portions, of which the middle one is fixed to the tibia, behind its inner tuberosity, and sends an expansion which covers the popliteus muscle; the internal portion passes forwards under the internal lateral ligament, and is inserted along the side of the inner tuberosity of the tibia; the third, broad and expanded, is reflected backwards and upwards behind the joint, and is inserted into the external condyle of the femur, becoming identified with the ligamentum posticum, fig. 116, 1. Direction—nearly vertical: structure—fleshy in the middle, tendinous at its extremities: relations—by the posterior surface with the biceps, semi-tendinosus, and fascia lata; by the anterior surface with the quadratus femoris, adductor magnus, the popliteal artery, inner head of the gastrocnemius and knee-joint; by the inner border with the gracilis and fascia lata; by the outer border with the sciatic nerve.

Combined actions.—These are usually called the ham-string muscles, as they enclose the ham, or space at the posterior aspect of the knee-joint; the biceps being placed at its external side, the other two at the internal. Their direct action is that of flexing the leg on the thigh, and this they do directly backwards, when they conspire in their action; but if they be made to act alternately, the leg will be rotated slightly inwards or outwards; the latter motion, however, can only take place in the semi-flexed position of the limb. In the standing posture, these muscles, by taking their fixed point below, will act on the pelvis so as to prevent its flexion forwards; and if the effort be continued, they will draw it directly backwards, and commence that series of muscular actions observable in tumbling and other feats of activity, in which the body is thrown backwards so as to form an inverted arch.

Muscles of the Leg.

ANTERIOR TIBIO-FIBULAR REGION.

546. In the interval between the tibia and fibula we find three long muscles, viz. tibialis anticus, extensor proprius pollicis, and extensor communis digitorum.

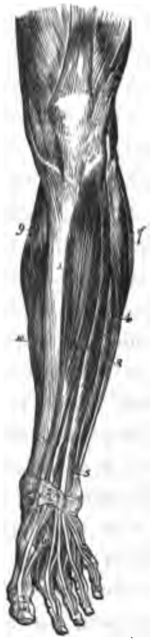
Dissection. To expose the fascia.—The subject being placed on its back, bend the knee and place under it a high block, so that the leg should form an inclined plane; turn the foot inwards, and fix it in that position. Now, make an incision through the skin, beginning above at the middle point, between the head of the fibula and the spine of the tibia, and continue it straight down over the middle of the ankle-joint and dorsum of the foot. As this is a very long incision, intersect it by a transverse one at each end, and another in the middle; raise the flaps of skin tightly, you will see the dense fascia of the leg beneath it; dissect back the flaps, and expose this membrane in its entire extent.

To expose the muscles.—Divide the fascia along the leg as you did the skin, but opposite the flexure of the ankle-joint leave undivided a band of it about an inch wide, where it stretches across obliquely from one ankle to the other, forming the anterior annular ligament. Beginning a little above the ankle, raise the fascia from the tendons, and, taking them as your guide, dissect it from below upwards from the muscles. (For the description of the annular ligament, see sect. 480.)

The muscles of the leg, taken altogether, may, to facilitate their classification, be divided into sets, each consisting of three. Thus, on the fore part of the leg, and lying between the tibia and fibula, we find the tibialis anticus, the extensor communis, and extensor pollicis, being the group which we are now examining. On the external side of the leg, and in close contact with the fibula, are placed the peroneus longus and brevis. The third muscle of this name is, in reality, a part of the extensor communis, and is separated from the other two by the breadth of the fibula. It still, however, is described as a separate muscle, probably to keep up the ternary division. Posteriorly, there are two sets, one being superficial, consisting of the gastrocnemius, soleus, and plantaris; and the other deep-seated, viz. tibialis posticus, flexor longus digitorum, and flexor longus pollicis.

547. *m. Tibialis anticus*, fig. 114, 1, (tibio-super-tarseus,) is situated at the front of the leg and the inner part of the foot, being extended from the upper end of the tibia to the first cuneiform bone. Form—elongated, thicker above than below. It *arises* from the external tuberosity of the tibia, and from about two-thirds of the flat surface beneath it,—from a small portion of the inter-osseous ligament,—from the fascia of the leg, and an aponeurotic septum placed between it and the extensor digitorum communis muscle; it is *inserted* into the internal surface of the first cuneiform bone, and the contiguous extremity of the first metatarsal bone. Direction—downwards, and a little inwards; structure—fleshy in the two upper thirds, tendinous in the lower; relations — the upper, or fleshy portion, corresponds in front with the fascia of the leg, to which it is adherent superiorly, behind with the inter-osseous ligament, on the fibular side with the extensor digitorum communis and extensor proprius pollicis, from which it is partly separated by the anterior tibial vessels. The tendon crosses obliquely, in front of the lower end of the tibia, the ankle-joint, and the anterior and inner part of the tarsus, being bound down by the anterior annular ligament, 2, which gives it a separate sheath.

Fig. 114.



548. *m. Extensor proprius pollicis*, fig. 114, 3, is situated between the tibia and fibula, at the fore part of the leg and on the dorsum of the foot along its inner border. Form—elongated,

flat, and compressed in the middle, pointed at the extremities. It *arises* from the internal surface of the fibula, for about the middle third of its extent, and from the contiguous surface of the inter-osseous ligament, nearly as far as the ankle; the fleshy fibres run obliquely forwards into a tendon placed at the anterior border of the muscle, which, after passing beneath the annular ligament and along the dorsum of the foot, is inserted into the base of the second phalanx of the great toe, having also an intimate connexion with the first: structure—tendinous below, fleshy superiorly: relations,—by the outer surface with the extensor digitorum communis, by the inner surface superiorly with the tibialis anticus and the anterior tibial vessels; the anterior border is overlapped for some way by the muscles just named, and is covered inferiorly by the anterior annular ligament, under which it passes in a separate groove, and by the integuments; the posterior border corresponds with the fibula and the inter-osseous ligament, and passes over the broad flat part of the tibia, the ankle-joint, the anterior tibial vessels, and dorsum of the foot.

549. *m. Extensor digitorum longus*, fig. 114, 4, is situated at the fore part of the leg and on the dorsum of the foot, extending from the head of the tibia to the toes. Form—elongated, flattened from side to side, but inferiorly it divides into four tendons. It *arises* from the external tuberosity of the tibia, from the anterior surface of the fibula for about two-thirds of its length; also from the inter-osseous ligament, from the aponeurotic septa intervening between it and the muscles, on either side, and from the fascia of the leg. The fleshy fibres from this extensive origin pass obliquely into three flat tendons placed on the fore part of the muscle; these descend beneath the annular ligament, in the same sheath with the peroneus tertius; and on the dorsum of the foot the inner one divides into two parts, so as to constitute four tendons, corresponding in number with the four smaller toes, into the last phalanges of which they are inserted; towards their termination each of the tendons expands into an aponeurosis, covering the upper surface of the phalanges; and this is strengthened by the tendons of the extensor brevis, and gives attachment also to the lumbricales and inter-ossei. Structure—fleshy and tendinous: relations—it is covered in front by the fascia of the leg, the

annular ligament and integument; posteriorly it rests on the fibula, the inter-osseous ligament, and the tibia; then crosses the ankle-joint, and the extensor brevis digitorum; externally it is in relation with the peronei muscles, internally with the tibialis anticus and extensor proprius pollicis; along its lower border lies the peroneus tertius.

550. *m. Peroneus tertius* (called also *anticus*, from its position with regard to the fibula) is placed along the fore part of the fibula at its lower third. It lies just below the extensor longus, with which its muscular fibres, 5, are united, and of which it is really but a part. Form—elongated and flat. It arises from the lower third of the fibula, being attached to the anterior border and inner surface of the bone; also from the inter-osseous ligament, and an aponeurosis which connects it on the outer side with the peroneus brevis; and is inserted inferiorly into the external surface of the tarsal end of the fifth metatarsal bone. Direction—vertical in the leg, obliquely forwards and outwards on the foot. Structure—fleshy in the upper portion, tendinous in the lower. Relations—the posterior border corresponds with the fibula, inter-osseous ligament, and peroneus brevis; the outer surface is covered by the fascia of the leg; the inner is confounded with the extensor digitorum communis. It passes, in conjunction with the common extensor, under the annular ligament, and is invested by the same synovial membrane; on the foot it is placed on the extensor digitorum brevis and last metatarsal bone.

551. *m. Extensor brevis digitorum*, 6, is situated on the dorsum of the foot. Form—broad and thin; narrow and undivided at its origin; it separates into four parts in front. It *arises* from the dorsal surface of the calcaneum, and from the ligament connecting that bone with the astragalus, and terminates in four tendons, the first or most internal of which is inserted into the tarsal end of the first phalanx of the great toe; the other three become severally united to the outer border of the extensor tendons, proceeding to the three next toes. Structure—fleshy and tendinous. Relations—it is covered by the tendons of the long extensor and peroneus tertius, and rests on the tarsus, metatarsus, and the dorsal inter-osseous muscles.

Actions.—A very slight effort of the extensor communis and extensor proprius pollicis extends the digital phalanges, and if their action be continued, they will be made to bend the foot upon the leg. This they are enabled to do by the manner in which their line of direction is altered by the annular ligament of the ankle-joint, as it gives them all the mechanical advantage of a pulley. The tibialis anticus and the peroneus tertius are the direct flexors of the foot on the leg, and if either act separately, it will give a slight inclination towards the corresponding side. In the erect position, these muscles take their fixed point below, and, by drawing on the bones of the leg, keep them perpendicular on the foot. The extensor brevis is obviously but an accessory to the long extensor; but, from the obliquity of its direction, it is fitted not only to extend the toes, but also to draw them somewhat outwards.

552. *m. Peroneus longus*, fig. 114, 7, (peroneo-sub-tarseus,) is situated at the outer side of the leg, and under the foot. Form—very long and narrow, reflected on itself inferiorly. It *arises* from the upper third of the external surface of the fibula — from a small part of the external tuberosity of the tibia, and from the fascia of the leg; also from aponeuroses interposed between it and the contiguous muscles, viz. the extensor communis digitorum on one side, and the soleus and flexor longus pollicis on the other. Proceeding from these attachments, it descends and becomes tendinous; the tendon passes, with that of the peroneus brevis, in a groove on the posterior surface of the external malleolus, where they are covered by a fibrous lamella extended from the end of the fibula to the calcaneum, and invested by a common synovial membrane. The tendons then separate; that of the peroneus longus proceeds in another groove on the external surface of the calcaneum, to which it is connected by a separate fibrous band. It then enters a groove on the cuboid bone, where it changes its direction, and inclines forwards and inwards beneath the foot, to be inserted into the tarsal end of the first metatarsal bone. Structure—tendinous at the lower, aponeurotic at the upper extremity, fleshy in the middle. Relations—in the leg it corresponds, by the outer surface, with the fascia of the leg; by the inner surface, with the fibula, extensor digitorum communis, and peroneus brevis; by the posterior surface, with the soleus superiorly, and flexor longus pollicis inferiorly. When passing across the foot, the

tendon runs close to the bones, and therefore above all the plantar muscles.

553. *m. Peroneus brevis*, fig. 114, 8, is situated at the external side and lower part of the leg, and at the outer part of the dorsum of the foot. Form — similar to that of the preceding muscle, but not so long. It *arises* from the external surface of the fibula for about the lower half of its extent, and from the inter-muscular septa which dip in between it and the contiguous muscles. The tendon passes behind the external malleolus in the same groove and sheath, is invested by the same synovial membrane with the preceding muscle, and is inserted into the base of the last metatarsal bone, after having traversed a separate groove in the calcaneum, situated above that for the tendon of the peroneus longus. Structure—tendinous at the lower extremity, fleshy superiorly: relations—by the outer surface, with the peroneus longus and the fascia of the leg; by the inner surface, with the fibula, the extensor digitorum longus, the peroneus tertius, and flexor longus pollicis muscles.

Actions.—The peroneus longus and brevis, by the change of their direction, after turning behind the external ankle, are enabled to draw the foot back, and so extend it on the leg. The peroneus tertius is, on the contrary, a flexor of the foot; it lies before the fibula, and combines with the extensor communis. The peroneus longus is enabled to evert the sole of the foot, by means of the mechanical advantage which it derives from turning round its external margin. This, however, is not readily perceptible in the natural condition of the limb; but, if the fibula be fractured, and the check afforded by the external ankle be in consequence diminished, it will take place to a considerable extent. When the peronei take their fixed point below, they act on the bones of the leg, and assist in maintaining them erect on the foot. This power is chiefly called into action when we stand on one leg. The weight of the body must then tend to incline the leg inwards; but the peroneus longus, acting from its fixed point in the sole of the foot, with the additional power given it by the pulley round which it turns, draws on the external side of the bones of the leg, and prevents them from obeying the influence which otherwise would incline them inwards.

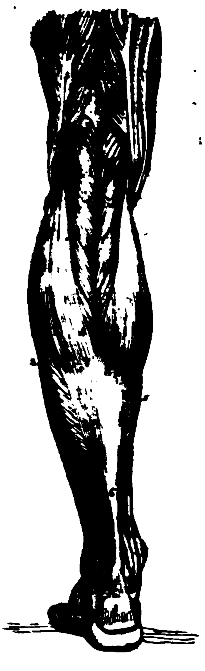
POSTERIOR TIBIO-FIBULAR REGION (SUPERFICIAL).

554. On the posterior part of the leg there are two sets of muscles, one superficial, the other deep-seated. The former consists of the gastrocnemius, the soleus, and plantaris; the latter of the popliteus, tibialis posticus, flexor communis digitorum, and flexor longus pollicis.

Dissection.—The gastrocnemius may be exposed without any difficulty, by dissecting off the fascia, commencing where it is continuous with that covering the popliteal space; after which, the internal head of the gastrocnemius may be raised, and its border reflected outwards. By this expedient the thin tendon of the plantaris will come into view, and afford a guide to its muscular belly, which may otherwise be raised with the external head of the gastrocnemius, with which it is closely in contact. The soleus may in the next place be detached, taking the inner surface of the tendo Achillis as a guide; previously to which, attention should be directed to the structure of that part of its upper border, between its tibial and fibular origins, which is arranged for the transmission of the posterior tibial vessels.

555. *m. Gastrocnemius*, or *gemellus*, fig. 115, 4, (bi-femoro-calcaneus,) is situated at the posterior aspect of the leg, forming the greater part of what is named the calf (*γαστηρ*, a belly; *κνημη*, the leg). Form—very thick and convex behind, plane in front, divided longitudinally at the upper extremity into two portions or heads, of which the inner is thicker and longer than the other. From their relative situations, they are named the outer and inner heads of the muscle; they leave an angular interval between them, which forms the lower part of the popliteal space. Each head of the muscle *arises* from the upper and back part of the corresponding condyle of the femur; their fleshy fibres descend converging, and both become gradually united, so as to form a thick muscular mass. Below the middle of the leg, the muscular structure ends in a broad strong tendon

Fig. 115.



(*tendo Achillis*) which is inserted into the lower part of the posterior extremity of the os calcis. Direction—vertical: structure—tendinous at the lower extremity, aponeurotic and fleshy at the upper, fleshy in the middle: relations — the posterior surface is covered by the fascia of the leg, the anterior rests on the popliteus, plantaris, and soleus muscles, and popliteal vessels; where its heads pass over the condyles, they are guarded by synovial membranes.

556. *m. Soleus*, 5, (tibio-peroneo-calcaneus,) is situated at the posterior part of the leg, of which, in conjunction with the preceding muscle, it forms the calf. Form—nearly oval, being much thicker and broader in the middle than at the extremities. Like the preceding muscle, it presents superiorly two attachments, though by no means so distinctly separated. Of these, the external one, longer and larger, *arises* from the posterior part of the head of the fibula, and from the surface beneath it for about a third of its extent; the inner portion arises from the middle third of the tibia, commencing below the oblique line which gives insertion to the popliteus; finally, in the space intermediate between the bones, the muscular fibres are attached to a tendinous band extended from one to the other, over the posterior tibial vessels, which it secures from pressure or injury. The fleshy fibres descend lower than those of the gastrocnemius, and end in a flat tendon, which soon becomes blended with the tendo Achillis. Direction—the muscular fibres converge to a species of aponeurotic raphé, which exists along the middle of the muscle: structure—aponeurotic and fleshy at its origin, fleshy in the middle, tendinous inferiorly: relations—behind with the gastrocnemius and plantaris muscles; in front, with the tibia and fibula, the peroneus longus, the flexor longus pollicis, tibialis posticus, and flexor longus digitorum muscles, and the posterior tibial vessels. The soleus and gastrocnemius, having but one common attachment inferiorly (tendo Achillis), and being fixed by three heads superiorly, form in reality one muscle, which is named by Meckel and others, triceps suræ.

The *tendo Achillis*, 6, formed by the junction of the tendinous structures in which the two preceding muscles terminate inferiorly, is situated at the posterior and inferior part of the leg; and is by far the thickest and strongest tendon in the body. Form—elongated, narrower in the middle than at the extremities, of which the superior is much broader than the inferior; where it passes over the posterior surface of the calcaneum, it is separated from the bone by a synovial membrane. It is covered behind by the skin and fascia of the leg; its anterior surface is separated by a considerable quantity of cellular tissue from the deep-seated muscles.

557. *m. Plantaris*, 7, is situated immediately behind the knee-joint and leg, between the gastrocnemius and soleus; it consists of a very long thin tendon, and a small pyriform muscular part, about two inches in length. It *arises* from the femur just above the external condyle, and from the posterior ligament of the knee-joint, where it is covered by the corresponding head of the gastrocnemius, and soon ends in a delicate tendon, which inclines inwards between the two large muscles of the calf of the leg, and running along the inner border of the tendo Achillis is inserted conjointly with it into the posterior surface of the calcaneum. Its direction, structure, and relations are here sufficiently indicated.

Actions.—The power of these muscles, as they are exerted successively in standing, walking, running, &c. is very considerable.

In walking, the gastrocnemius and soleus take their fixed point above, and by drawing on the os calcis lift it from the ground, so that the foot is made to represent an inclined plane. By this action an impulse is communicated to the body, and a direct tendency is given to progression. When the body is thus supported on the elevated foot, the opposite limb can be carried forward to its destination unimpeded by the inequalities of the surface over which it has to pass.

In standing, the soleus takes its fixed point at the os calcis, and, by drawing on the bones of the leg, retains them perpendicularly on the foot, thus preventing them from obeying the influence of the weight of the body, which constantly tends to bend them forwards. If this effort be carried as far as it will admit of, the gastrocnemius and popliteus will bend the femur on the tibia, and if at the same time the semi-tendinosus, semi-membranosus, and biceps, be made to act on the ischium, so as to draw it downwards and backwards, the commencement of that series of muscular actions is made by which the body is retroverted, and carried towards the ground, as we see when a tumbler or mountebank makes an inverted arch of his body, the head and heels being brought to the same plane.

POSTERIOR TIBIO-FIBULAR REGION (DEEP-SEATED).

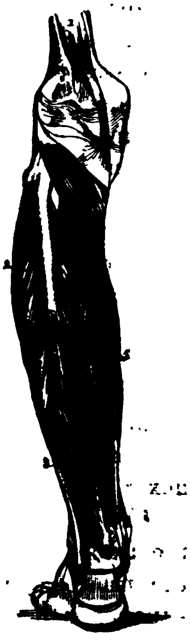
558. The muscles here placed are in close contact with the bones; they are the popliteus, flexor longus digitorum, flexor longus pollicis, and tibialis posticus.

Dissection. To expose the deep fascia.—Detach the two heads of the gastrocnemius from the condyles, also the plantaris: then separate the soleus from the tibia and fibula, proceeding from below upwards. When this is done, turn these muscles down towards the foot, and you will find behind and just beneath the knee-joint the popliteus muscle; and you will observe, that this as well as the long muscles, which lie lower down, and the posterior tibial vessels, are bound down by a thin fascia (the deep-seated fascia of the leg). This membrane extends down from the tendon of the semi-membranosus muscle, becoming connected on each side with the borders of the bones, and towards the ankles with the sheaths of the tendons; and if traced along the interval between the inner ankle and the heel, it will be found to cover the vessels, and to terminate at the internal annular ligament.

To expose the deep-seated muscles.—Pinch up the fascia with your forceps, and detach it from the tendons of the muscles behind the ankles:—taking these as a guide, proceed upwards to the popliteus. In this way the deep-seated set of muscles become exposed, (viz. the flexor communis, placed along the tibia, the flexor pollicis on the fibula, and the tibialis posticus between both, and partly concealed by them,) and also the vessels which rest upon them.

559. *m. Popliteus*, fig. 116, 4, is situated immediately behind and beneath the knee-joint, extending from the outer surface of the external condyle of the femur downwards and inwards to the tibia. It is flat and somewhat triangular in its form, for it gradually widens as it descends. It *arises* by a flat, thick tendon, about an inch in length, from a depression on the outer side of the external condyle, beneath the attachment of the corresponding lateral ligament of the knee-joint, and is inserted into all that triangular surface of the tibia which is above the posterior oblique line. Direction — obliquely downwards and inwards: structure — tendinous at its attachment to the femur, aponeurotic and fleshy in the rest of its extent: rela-

Fig. 115.



tions—behind, with an expansion continued over it from the semi-membranosus muscle, also with the popliteal vessels and the plantaris and gastrocnemius muscles; in front with the knee-joint, the tibia, and tibialis posticus muscle. The tendon by which it is connected to the femur adheres by its anterior surface to the external semi-lunar cartilage, (which sometimes is grooved for it,) and is invested by the synovial membrane of the knee-joint: its posterior surface is crossed by the external lateral ligament of the knee-joint and by the biceps flexor muscle.

Actions.—The popliteus assists in flexing the leg on the thigh, and vice versâ; but when the leg is flexed, it draws the inner border of the tibia backwards, turning it in such a way that the toe is inclined towards the foot of the opposite side.

560. *m. Flexor longus digitorum pedis*, fig. 116, 5, (flexor perforans,) is situated deeply at the posterior part of the leg, from which it is prolonged forwards into the sole of the foot. It extends from the upper part of the tibia to the phalanges of the toes. The muscle at its commencement is thin and pointed, but gradually increases, and then diminishes again as its fibres end in a tendon. Finally, the tendon becomes divided into four slips previously to its insertion. It *arises* from the posterior surface of the tibia, below the oblique line which gives attachment to the popliteus and soleus, and continues its attachment to within three inches of the inner ankle; some fibres also arise from an aponeurosis which connects it with the tibialis posticus and flexor longus pollicis. The fleshy fibres pass obliquely backwards into a tendon situated at the posterior aspect of the muscle. The tendon passes behind the internal malleolus, along a groove common to it and the tibialis posticus (the latter being next to the bone); thence it is directed beneath the arch of the os calcis, obliquely forwards and outwards, into

the sole of the foot, where it crosses the tendon of the flexor longus pollicis, with which it is connected by a transverse tendinous slip. The tendon, fig. 118, 2, then divides into four processes, corresponding with the four smaller toes, and as they run along their under surface, they are bound down to the phalanges by fibrous sheaths; opposite the second phalanx, each tendon passes through a fissure in the tendon of the flexor brevis, 5, (whence the term perforans is applied to the one, perforatus to the other), and, finally, they are inserted into the bones of the third phalanges.

Previously to its division, the tendon of the flexor longus gives insertion to an accessory muscular structure (flexor accessorius), which connects it with the calcaneum, and materially modifies the direction of its action on the toes. Close to the point of division the tendons give origin to four small muscles (lumbricales) which may also be considered as accessories to the flexor longus.

Though in the dried bone only one impression is marked for the tendons of the tibialis posticus and flexor longus, behind the malleolus, the fibrous sheath which retains them in their situation is divided into two parts by a septum, or partition, so that each runs in a separate groove lined by a distinct synovial membrane. The direction is vertical in the leg, horizontal in the foot: structure—fleshy and tendinous: relations—in the leg it is bound down by the deep fascia, and covered by the posterior tibial vessels, which separate it from the soleus; its anterior surface rests against the tibia, and overlaps the tibialis posticus muscle; in the foot its tendon lies between those of the flexor longus pollicis, which is above it, and the flexor brevis digitorum, which lies beneath it.

561. *m. Flexor longus pollicis pedis*, fig. 116, 6, is situated close to the fibula, along the external side of the leg, and at the under and inner part of the foot. It *arises* from the posterior surface of the fibula (its inferior two-thirds), also slightly from the inter-osseous ligament, and from the intermuscular septa interposed between it and the peronei externally, and the flexor longus digitorum and tibialis posticus internally. The fleshy fibres, continuing to arise nearly as far as the external ankle, pass obliquely backwards into a tendon placed on their posterior surface; the tendon traverses a groove on the tibia, external to

that which transmits the tibialis posticus and flexor digitorum, then passes through another in the posterior border of the astragalus, in which it is retained by a fibrous band and a synovial membrane. It then runs in a groove beneath the tubercle at the inner edge of the os calcis, and so reaches the sole of the foot, where, after being connected to the common flexor by a tendinous slip, it turns forwards beneath the metatarsal bone of the great toe, fig. 118, 1, and between the two heads of the flexor brevis pollicis, and, after running through a fibrous sheath which binds it to the first phalanx of the great toe, is inserted into the base of the second. Structure—fleshy in the greater part of its extent, tendinous inferiorly: relations—in the leg it is bound down by the deep fascia which separates it from the soleus; its anterior surface rests on the fibula, and overlaps the tibialis posticus muscle and the peroneal artery: its relations in the sole of the foot have already been sufficiently indicated.

562. m. *Tibialis posticus*, fig. 116, 7, (tibio-sub-tarseus,) lies deeply behind the bones of the leg and the inter-osseous ligament, and between the two preceding muscles, but commences about three inches higher up. Its superior extremity is divided into two short processes, or heads, by an angular interval for the transmission of the anterior tibial artery and vein. It *arises* from the posterior surface of the tibia, beginning along the oblique line of insertion of the popliteus, its fibres continuing to be attached to the bone for some way down, also from the posterior and inner surface of the fibula and from the interosseous ligament for two-thirds of its length; some fibres arise also from the inter-muscular septa, between it and the flexor muscles. The muscular fibres end in a flat strong tendon, which winds round the internal malleolus close to the bone, and in a sheath appropriated to itself, whence it is directed forwards, beneath the tarsus, to be inserted into the tuberosity on the plantar surface of the scaphoid bone, several fibres being also prolonged to the first cuneiform bone, and some obliquely into the sole of the foot, as far as the second and third metatarsal bones. Direction—vertical in the leg, horizontal in the foot: structure—fleshy along its points of attachment to the tibia and inter-osseous ligament, aponeurotic for the most part where it arises from the fibula, the aponeurosis being usually continued down for some way upon its posterior surface; its lower part is

altogether tendinous: relations—in the leg it is overlapped and concealed in the greater part of its extent by the two flexor muscles, but superiorly the part which is left uncovered by them supports the posterior tibial vessels; its anterior surface rests against the inter-osseous ligament and the tibia and fibula, from which it arises; its tendon runs close to the inner ankle and tarsal bones, and where it slides under the astragalus is thickened by a cartilaginous or bony deposit within its fibres, analogous, in form and use, to the sesamoid bones in other situations.

Actions.—Like their antagonists on the fore part of the leg, the two flexor muscles act, in the first instance, on the phalanges of the toes, which they curve or bend, and then, by continuing their effort, they act on the foot. The latter effect they are enabled to produce by means of the mechanical advantage afforded to them by the pulley-like surface on which they slide as they pass from the leg into the sole of the foot. By this provision the flexor muscles conspire with the soleus and gemellus in extending the foot on the leg, for instance in the effort to stand on tip-toe.

The direct agent in extending the foot upon the leg is the tibialis posticus; but from its position it is also enabled to incline the foot inwards, thus antagonising the peroneus tertius, which tends to turn it outwards. It may also, by elevating the inner border of the foot, turn the sole inwards; which action is directly opposed to that of the peroneus longus, which tends to incline it outwards.

It may be observed, that the toes would, in all cases, be drawn inwards whilst they are being flexed by the flexor communis, in consequence of the oblique direction of its tendon, but for the influence exerted upon it by the accessory muscle, which is connected with it in the sole of the foot. The direction of the latter being from behind forwards, it is well fitted by its contraction to modify the action of the long flexor on the toes, and to draw them towards the heel, where its fixed point of attachment is situated.

The action of these muscles may be reversed; for they may take their fixed points below at the foot, and from thence draw on the bones of the leg, so as to keep them in the erect position and prevent their inclining forwards.

Muscles of the Foot.

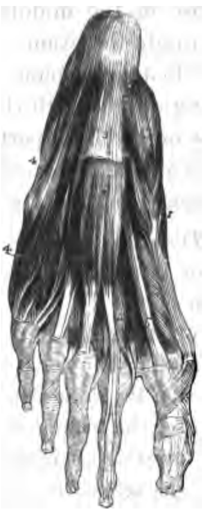
563. The only muscle on the dorsum of the foot is the extensor brevis digitorum, which has been already described (sect.

551), together with the extensor longus, as they conspire in their actions; the present section therefore includes only the muscles in the sole of the foot. These may be considered as divisible into three regions, corresponding with the two borders and the intermediate space; the internal set consisting of the muscles of the great toe, the external those of the little toe, those in the middle being common to all. But in order to facilitate the examination of the parts contained in the sole of the foot, it is found more convenient to divide them into layers, lying one beneath the other; more particularly as, like the muscles on the back part of the leg, they are found to be separated into a superficial and deep set by a layer of fascia interposed between them and binding down the latter.

Dissection. To expose the plantar fascia.—The subject, or the limb, if it be detached, being placed in the prone position, lay the dorsum of the foot on a high block, so as to bring the sole fully into view; secure it in that position. Make an incision from behind forwards in the middle of the sole, beginning over the heel. Cut down through the thick skin and the cushion of granular fat at the heel, until you see the white fibres of the fascia: then taking these as a guide, and everting the margins of the incision, lateralise your knife and dissect the skin off the fascia from behind forwards. You will observe its middle part to spread out beneath the metatarsus, and to give off five processes, which run along to the extremities of the metatarsal bones: the external portion, which binds down the muscles of the little toe, is thick and firm; but the internal one, which corresponds with the muscles of the great toe, is a thin membrane which appears to be prolonged from the fascia on the dorsum of the foot, and not to be properly an offset of the true plantar fascia (see its description, sect. 590).

To expose the first layer of muscles, fig. 117.—These are three, viz. the abductor pollicis at the inner side, the abductor of the little toe at the outer, and the short flexor of the toes in the middle. The abductor pollicis is readily brought into view by raising the thin fascia which covers it, and dissecting it off, beginning over its tendon and thence proceeding backwards. The abductor of the little toe is exposed by raising the outer division of the plantar fascia from its attachment to the fifth metatarsal bone and reflecting it backwards. Now observe that the broad part of the fascia appears as if tucked in at its sides by processes or septa, which separate the middle from the lateral groups of muscles. Insert the knife under the fascia, raise it from the muscles a little, and then cautiously detach it from them, proceeding from before backwards. When severed from the calcaneum, you may carry it forwards, still leaving it attached by its digital processes. By these means you bring into view the short flexor muscle.

Fig. 117.



564. *m. Abductor pollicis*, fig. 117, 1, is placed along the inner side of the sole of the foot. It *arises* from the inner border of the protuberance of the calcaneum, from the internal annular ligament (sect. 588), from the septum between it and the flexor brevis digitorum, and from the superior surface of the plantar fascia. The fleshy fibres end in a tendon, which, after uniting with the external head of the flexor brevis pollicis, is inserted into the inner border of the base of the first phalanx of the great toe. Direction—parallel with the inner border of the foot: structure—fleshy and tendinous: relations—its plantar surface is covered by the skin and fascia, the superior surface is in contact with the tendinous insertion of the tibialis posticus, with the flexor brevis pollicis with which it is identified, and with the internal plantar vessels.

565. *m. Flexor brevis digitorum*, 2, (flexor perforatus,) is placed in the middle of the sole of the foot, in intimate contact with the plantar fascia. It *arises* from the plantar surface of the calcaneum, immediately before its internal or greater tuberosity, from the plantar fascia, 3, and the intermuscular septa on each side. It soon terminates in four thin tendons corresponding with the four lesser toes; and opposite the extremity of the first phalanx each tendon divides into two fasciculi, so as to leave a fissure for the transmission of the tendon of the flexor longus, after which the fibres unite again into a broad lamella which is inserted into the under surface of the second phalanx. Direction—from behind forwards: structure—tendinous and fleshy behind, fleshy in the middle, tendinous in front: relations—the lower surface is in intimate contact with the plantar

fascia, the upper with the flexor accessorius, with the tendons of the flexor longus digitorum, the lumbricales, and the plantar vessels.

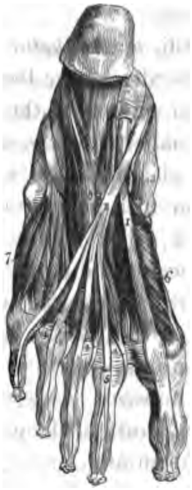
566. *m. Abductor digiti minimi*, 4, is placed along the external border of the foot. It *arises* from the external border and under surface of the calcaneum, immediately before its external or smaller tubercle, and from the upper surface of the process of the plantar fascia, which extends from that tubercle to the base of the fifth metatarsal bone. The fleshy fibres end in a tendon, which, after sliding along a smooth impression on the inferior surface of the head of the fifth metatarsal bone, is inserted into the external surface of the base of the first phalanx of the little toe. Its direction and structure are here sufficiently indicated. Relations—the inferior surface is covered by the plantar fascia; the superior is in contact with the external head of the flexor accessorius, the ligamentum longum plantæ, and the flexor brevis digiti minimi.

Dissection.—To *expose the second layer* of plantar muscles, fig. 118. Separate the two abductors and the short flexor from the calcaneum by inserting the knife under the border of each successively, and cutting obliquely backwards close to the bone. Then draw them forwards, leaving them still attached by their insertions, in order that you may restore them to their original positions, and inspect their attachments and relations again.

When these muscles are removed, a thin lamella (*deep plantar fascia*) of membrane will be observed, extending across from one side of the foot to the other, separating the first from the second layer of muscles, consisting of the tendons of the flexor longus pollicis, those of the flexor communis, and its accessories, viz. the flexor accessorius and lumbricales. The long tendons will be observed to cross one another at an acute angle, that of the flexor pollicis inclining inwards, and placed on a plane superior to the tendon of the flexor communis, whose direction is obliquely outwards, as if towards the base of the fifth metatarsal bone.

567. *m. Flexor accessorius* is not unfrequently termed *massa carnea;* but its structure does not at all warrant such an appellation, as one of its origins is tendinous, and at its point of union with the flexor longus it is for the most part tendinous. It is divided posteriorly into two heads, fig. 118, 3, 3, of which the internal or larger one *arises* from the inner or concave surface

Fig. 118



of the calcaneum; the external, flat and tendinous, arises from the plantar surface of that bone, a little before its external tubercle. These origins unite at an acute angle, and form a flat fleshy mass, which becomes united to the posterior border, as well as to the two surfaces of the tendon of the flexor longus at its point of division. It may be observed, that the fibres of the accessory muscle, where they enclose the tendon of the long flexor, are tendinous, and so arranged as to form a groove, within which it is lodged.

568. *m. Lumbricales*, fig. 118, 4, 4, are four small tapering muscles, in form like worms, whence their name is derived; they *arise* from the tendons of the flexor communis digitorum at their point of division; from which they pass forwards to the inner side of each of the lesser toes, where each becomes a thin tendon, which is inserted into the base of the first phalanx at its inner border, and also becomes united to the tendinous expansions of the extensor muscles on the dorsal surface of the phalanges.

Dissection.—Cut the flexor tendons across, detach the flexor accessorius from its origin, and draw them forwards or over the sides of the foot. When these muscles are removed, the third layer is exposed, filling up the deep irregular part of the sole of the foot.

569. *m. Flexor brevis pollicis*, fig. 119, 1, is single and pointed behind, but divided into two parts or heads in front. It *arises* by a flat tendinous process, which extends along the greater part of its upper surface, from the inner border of the cuboid bone, slightly from the contiguous margin of the external and middle cuneiform bones, and from the tendinous fibres sent into the sole of the foot from the tendon of the tibialis posticus. These origins can be best perceived when the muscle is cut across and detached carefully from before backwards. The fleshy mass presents two heads, which are inserted, one into the inner, the other into the external border of the base of the first phalanx of the great toe; each head is also intimately connected

with one of the sesamoid bones beneath the articulation. Moreover, before reaching its points of insertion, an intimate union is established between this muscle and the abductor pollicis on the one side, and adductor on the other. The tendon of the flexor longus runs along the interval between the heads of the short flexor.

Fig. 119.

570. *m. Adductor pollicis pedis*, fig. 119, 2, is situated obliquely in the sole of the foot, forming a short, thick, fleshy mass. It *arises* from the cuboid bone, from the tarsal extremity of the third and fourth metatarsal bones, also from the sheath of the peroneus longus muscle, 7, and is inserted, conjointly with the external head of the flexor brevis pollicis, into the base of the first phalanx of the great toe.

The adductor of the great toe and its short flexor are thus found to be intimately united at their insertion, and if they be cut across about an inch behind the first joint, and reflected forwards, two small sesamoid bones will be found connected with their tendons, just as the patella is in the extensor tendons of the knee-joint. Like the latter bone, one of their surfaces is smooth, and enters into the composition of the articulation, being lined by the synovial membrane, and, like it, they are developed in the substance of the tendons, to increase their power of action.

571. *m. Transversus pedis*, fig. 119, 3, is a narrow flat fasciculus of fleshy fibres, stretched beneath the digital extremities of the metatarsal bones, being interposed between them and the flexor tendons. Its external extremity is attached usually to the lateral ligament connecting the fifth metatarsal bone with the first phalanx of the little toe; sometimes it commences at the fourth; it passes from without inwards, its fibres being connected with the heads of the fourth, third, and second metatarsal bones, or rather with the ligaments passing from them to the phalanges. It thus reaches the ball of the great toe, where it becomes blended with the fibres of the adductor pollicis.

572. *m. Flexor brevis digiti minimi*, fig. 119, 4; fig. 118, 7, is placed at the external side of the sole of the foot; it arises tendinous from the base of the fifth metatarsal bone, and from the sheath of the peroneus longus; the fleshy fibres terminate in a tendon, which is inserted into the base and external border of the first phalanx of the little toe. Direction—horizontally forwards: structure—fleshy in the middle, tendinous at the extremities: relations—its superior surface is in contact with the fifth metatarsal bone; the inferior is covered partly by the abductor digiti minimi, partly by the plantar fascia.

573. *m. Inter-ossei*, as their name implies, are placed between the metatarsal bones, filling up the intervening spaces. There are seven in all. On the dorsal aspect of the metatarsus four of these muscles are perceptible, but still they dip down into the sole of the foot, where the other three are altogether situated; hence it is that in the latter situation their appearance and arrangement are somewhat complex.

574. The *dorsal* or *superior inter-ossei* closely resemble one another in appearance and mode of attachment. Their fibres arise from the contiguous surfaces of the bones between which they are placed, and pass obliquely forwards to a slight tendon that runs along the centre of each, so that they form a double penniform muscle, the posterior extremity of which is bifid, leaving an angular interval for the passage of the perforating branches, which pass from the plantar to the dorsal arteries. The two first dorsal inter-ossei belong to the second toe, being inserted, the one into the internal, the other into the external side of its first phalanx, and into the margins of the extensor tendon as it expands upon its dorsal surface. The third is inserted into the external side of the first phalanx of the third toe, and the fourth terminates in like manner in the first phalanx of the corresponding toe, fig. 119, 5, 5.

575. The *plantar* or *inferior inter-ossei* are not, strictly speaking, situated between the metatarsal bones; they are placed rather beneath the third, fourth, and fifth metatarsal bones, inclining somewhat towards their inner border.

The *first* plantar inter-osseous muscle arises along the inner border of the third metatarsal bone. The fleshy fibres end in a tendon, which is inserted into the base of the first phalanx of the third toe, becoming blended with the tendinous expansion of the extensor communis.

The *second* plantar inter-osseous muscle, fig. 119, 6, arises from the inner side of the fourth metatarsal bone, and is inserted into the inner border of the first phalanx of the corresponding toe and the extensor tendon.

The *third* plantar inter-osseous muscle, fig. 119, 6, arises from the inner side of the fifth metatarsal bone, and is inserted into the base of the first phalanx of the little toe and the extensor tendon.

Actions.—Several anatomists name the different inter-osseous muscles, not from their numerical order, first, second, third, &c. but from their actions and uses. Thus, the second, third, and fourth of the dorsal set are abductors of the corresponding toes, inasmuch as they are inserted into the external side of their phalanges ; but the first dorsal and the three plantar muscles are adductors, so that, if all four act together, they will draw the four lesser toes to the great one.

TABLE OF THE MUSCLES

IN THE ORDER OF DISSECTION.

THE student, to whom the head and neck are allotted, will find sixty-six muscles at each side, disposed in sets or groups in particular parts, technically termed regions. He will find it convenient to dissect them in the following order. When a muscle forms part of two regions, it is enumerated in each, but is included within brackets ( ).

MUSCLES OF THE HEAD AND NECK.

Epicranial Region (sect. 337).
Occipito-frontalis.

Auricular Region (363).
Attollens aurem.
Retrahens aurem.
Attrahens aurem.

MUSCLES OF THE EYE-LIDS AND ORBIT.

Palpebral Region (340).
Orbicularis palpebrarum.
Corrugator supercilii.
(Levator palpebræ.)
(Tensor tarsi.)

Orbital Region (367).
Rectus superior.
——— inferior.
——— internus.
——— externus.
Obliquus superior.
——— inferior.
Levator palpebræ.
Tensor tarsi.

MUSCLES OF THE FACE.

Nasal Region (345).
Pyramidalis nasi.
Compressor narium.
Levator labii superioris alæque nasi.
Depressor labii superioris alæque nasi.

Superior Maxillary Region (350).
Levator labii superioris.
——— anguli oris.
Zygomaticus major.
——— minor.

Inferior Maxillary Region (353).
Triangularis oris.
Depressor labii inferioris.
Levator labii inferioris.

Inter-maxillary Region (356).
Buccinator.
Orbicularis.

Temporo-maxillary Region (358).
Masseter.
Temporalis.

Pterygo-maxillary Region (361).
Pterygoideus internus.
——— externus.

MUSCLES OF THE NECK.

Superficial Region (374).
Platysma myoides.
Sterno-cleido-mastoideus.

Sterno-hyoid Region (385).
Sterno-hyoideus.
Sterno-thyroideus.
Thyro-hyoideus.
Crico-thyroideus.
Omo-hyoideus.

Submaxillary Region (376).
Digastricus.
Stylo-hyoideus.
Stylo-glossus.
Stylo-pharyngeus.

Genio-hyoid Region (380).
Mylo-hyoideus.
Genio-hyoideus.
Hyo-glossus.
Genio-hyo-glossus.
Lingualis.

Muscles of the Pharynx (396).
Constrictor inferior.
——— medius.
——— superior.
(Stylo-pharyngeus.)
(Palato-pharyngeus.)

Muscles of the Soft Palate (401).
Levator palati.
Circumflexus palati.
Azygos uvulæ.
Palato-glossus.
(Palato-pharyngeus.)

Muscles of the Larynx (407).
(Crico-thyroideus.)
Crico-arytænoideus posticus.
Crico-arytænoideus lateralis.
Thyro-arytænoideus.

Arytænoideus.
Arytæno-epiglottideus.
Thyro-epiglottideus.

Vertebral Region (390).

Scalenus anticus.
Scalenus posticus.
Rectus capitis anticus major.
——————— minor.
Rectus lateralis.
Longus colli.

MUSCLES OF THE UPPER EXTREMITY.

There are fifty-three muscles in each limb (including the pectorales, subclavius, and serratus), which may be examined one after another, in the order here set down.

Anterior Thoracic Region (439).

Pectoralis major.
——————— minor.
Subclavius.

Lateral Thoracic Region (442).

Serratus magnus.

MUSCLES OF THE SHOULDER.

Acromial Region (443).

Deltoideus.

Scapular Region, posterior (444).

Supra-spinatus.
Infra-spinatus.
Teres minor.
——— major.

Scapular Region, anterior (448).

Sub-scapularis.

MUSCLES OF THE ARM.

Humeral Region (449).

Coraco-brachialis.
Biceps flexor cubiti.
Brachialis anticus.
Triceps extensor cubiti (452).

MUSCLES OF THE FORE-ARM.

Brachial Region, inner and anterior (454).

Pronator radii teres.
Flexor carpi radialis.
Palmaris longus.
Flexor carpi ulnaris.
——— digitorum sublimis.
——————— profundus.
(Lumbricales.)
Flexor pollicis longus.
Pronator quadratus.

Radial Region (463).

Supinator radii longus.
Extensor carpi radialis longior.
——————————— brevior.
Supinator radii brevis.

Brachial Region, posterior (466).

Anconeus.
Extensor digitorum communis.
——————— minimi digiti.
——————— carpi ulnaris.
——————— ossis metacarpi pollicis.
——————— primi internodii pollicis.
——————— secundi internodii pollicis.
——————— indicis.

MUSCLES OF THE HAND.

Palmar Region (475).

Abductor pollicis.
Opponens pollicis.
Flexor brevis pollicis.
Adductor pollicis.

Palmaris brevis.
Abductor digiti minimi.
Flexor brevis digiti minimi.
Adductor digiti minimi.

Lumbricales.
Inter-ossei.

MUSCLES OF THE TRUNK.

Omitting the pectorales, subclavius, and serratus magnus, which are usually taken with the upper extremity, we find in the trunk of the body ninety muscles at each side, together with the diaphragm and levator ani, which are single.

MUSCLES OF THE ABDOMEN.

Abdominal Region (487).

Obliquus externus abdominis.
——————— internus.
Cremaster.
Transversalis.
Rectus abdominis.
Pyramidalis.
Quadratus lumborum.

MUSCLES OF THE THORAX.

Anterior Thoracic Region (439).

(Pectoralis major.)
(Pectoralis minor.)
(Subclavius.)

Lateral Thoracic Region (442).

(Serratus magnus.)

Costal Region (497).

Inter-costales, [externi, interni.]
Levatores costarum.
Triangularis sterni.
Diaphragma.

MUSCLES OF THE PELVIS AND PERINÆUM.

Iliac Region (516).

Psoas magnus.
——— parvus.
Iliacus.

Perinæal Region (504).

Sphincter ani.
Transversus perinæi.
Accelerator urinæ.
Erector penis.
Levator ani.
Coccygeus.
Compressor urethræ.
(Erector clitoridis.
Constrictor vaginæ.)

MUSCLES OF THE BACK.

These are arranged in layers.

Dorsal Region (413).

1. Trapezius.
   Latissimus dorsi.
2. Levator anguli scapulæ.
   Rhomboideus minor.
   ———————— major.
3. Serratus posticus superior.
   ———————— inferior.
   Splenius colli.
   ——— capitis.
4. Sacro-lumbalis.
   Cervicalis ascendens.
   Longissimus dorsi.
   Transversalis colli.
   Trachelo-mastoideus.
   Spinalis dorsi.
   Complexus.
5. Semi-spinalis dorsi.
   Semi-spinalis colli.
   Inter-spinales.
   Inter-transversales.
   Multifidus spinæ.
   (Levatores costarum.)

Rectus capitis posticus major.
———————————— minor.
Obliquus capitis superior.
——————— inferior.

MUSCLES OF THE LOWER EXTREMITY.

In each limb there are fifty-six muscles, which may be dissected in the following order.

MUSCLES OF THE THIGH.

Femoral Region, anterior (528).

Tensor vaginæ femoris.
Sartorius.
Rectus.
Crureus.
Vastus externus.
——— internus.

Femoral Region, internal (537).

Gracilis.
Pectineus.
Adductor longus.
———— brevis.
———— magnus.

Gluteal Region, superficial (519).

Gluteus maximus.
——— medius.
——— minimus.

Gluteal Region, deep-seated (523).

Pyriformis.
Gemellus superior.
Obturator internus.
Gemellus inferior.
Quadratus femoris.
Obturator externus.

Femoral Region, posterior (543).

Biceps femoris.
Semi-tendinosus.
Semi-membranosus.

MUSCLES OF THE LEG.

Tibio-fibular Region, anterior (546).

Tibialis anticus.
Extensor pollicis.
——— digitorum longus.
Peroneus tertius.
(Extensor digitorum brevis.)
Peroneus longus.
——— brevis.

Tibio-fibular Region, posterior superficial (554).

Gastrocnemius.
Plantaris.
Soleus.

Deep-seated (558).

Popliteus.
Flexor longus digitorum pedis.
———— pollicis pedis.
Tibialis posticus.

MUSCLES OF THE FOOT.

Dorsal Region (551).

Extensor digitorum brevis.

Plantar Region (563).

Abductor pollicis.
Flexor brevis digitorum.
Abductor digiti minimi.

Flexor accessorius.
Lumbricales.

Flexor brevis pollicis.
Adductor pollicis.
Flexor brevis digiti minimi.

Transversus pedis.
Inter-ossei.

TABLE OF THE MUSCLES,

ARRANGED AFTER THE MANNER OF DR. BARCLAY, ACCORDING TO THEIR ACTIONS.

THE HEAD IS MOVED

Forwards by

Platysma myoides
Sterno-mastoideus
Rectus anticus major
———— minor,

Assisted (when the lower jaw is fixed) by

Mylo-hyoideus
Genio-hyoideus
Genio-hyo-glossus
Digastrici.

Backwards by

Part of trapezius
Splenius capitis
Complexus
Trachelo-mastoideus
Rectus posticus major
———— minor
Obliquus capitis superior.

To either side by

Platysma myoides
Sterno-mastoideus
Part of trapezius
Splenius capitis
———— colli
Trachelo-mastoideus
Complexus.

THE NECK IS MOVED

Forwards by

Platysma myoides
Sterno-mastoideus
Digastricus
Mylo-hyoideus
Genio-hyoideus
Genio-hyo-glossus
Omo-hyoidei
Sterno-hyoidei
Thyro-hyoidei
Rectus anticus minor
Longus colli.

Backwards by

Part of trapezius
Rhomboideus minor
Serratus posticus superior
Splenius capitis
———— colli
Complexus
Trachelo-mastoideus
Transversalis colli
Interspinales colli
Semi-spinales colli
Rectus posticus major
———— minor
Obliquus capitis superior
———— inferior
Scaleni postici
Levator scapulæ.

Laterally by

Various combinations of those muscles which separately move it forwards and backwards, assisted by the scaleni, inter-transversales, and recti laterales.

THE TRUNK IS MOVED

Forwards by

Rectus abdominis
Pyramidalis
Obliquus externus abdominis
———— internus
Psoas magnus
———— parvus,

Assisted (when the arms are carried forwards) by

Pectoralis major
———— minor
Serratus magnus.

Backwards by

Trapezius
Rhomboideus major
Latissimus dorsi
Serratus posticus superior
———— inferior
Sacro-lumbalis
Longissimus dorsi
Spinales dorsi
Semi-spinales dorsi
Multifidus spinæ
Inter-transversales dorsi et lumborum.

Laterally by

Obliquus externus
———— internus
Quadratus lumborum
Longissimus dorsi
Sacro lumbalis
Serrati postici
Latissimus dorsi.

THE SCAPULA IS MOVED

Upwards by	*Downwards by*	*Forwards by*	*Backwards by*
Trapezius	Lower part of trapezius	Pectoralis minor	Part of trapezius
Levator scapulæ	Latissimus dorsi	Serratus magnus.	Rhomboidei
Rhomboidei.	Pectoralis minor.		Latissimus dorsi.

THE HUMERUS IS MOVED

Forwards by	*Backwards by*	*Inwards by*	*Rotated inwards by*
Part of deltoid	Part of deltoid	Part of pectoralis major	Subscapularis,
Part of pectoralis major,	Teres major	Latissimus dorsi.	*Assisted occasionally by*
Assisted in some circumstances by	—— minor		Pectoralis major
Biceps	Long head of triceps		Latissimus and teres major.
Coraco-brachialis.	Latissimus dorsi.		*Outwards by*
			Supra-spinatus
			Infra-spinatus
			Teres minor.

THE FORE-ARM IS MOVED

Forwards by	*Backwards by*	*Rotated inwards by*
Biceps	Triceps	Pronator teres
Brachialis anticus	Anconeus.	Flexor carpi radialis
Pronator teres,		Palmaris longus
Assisted by		Flexor sublimis
Flexor carpi radialis		Pronator quadratus.
—— sublimis		*Outwards by*
—— ulnaris		Biceps
Supinator longus.		Supinator brevis
		Extensor secundi internodii.

THE CARPUS IS MOVED

Forwards by	*Backwards by*	*Outwards by*	*Inwards by*
Flexor carpi radialis	Extensor carpi radialis longior	Flexor carpi radialis	Flexor sublimis
Palmaris longus	—— brevio	Extensor carpi radialis longior	—— carpi ulnaris
Flexor sublimis	Extensor secundi internodii	—— brevior	—— profundus
—— carpi ulnaris	Indicator	Extensor ossis metacarpi.	Extensor communis digitorum
—— profundus	Extensor communis digitorum	—— primi internodii.	—— minimi digiti
—— longus pollicis.	—— proprius pollicis.		—— carpi ulnaris.

THE THUMB IS MOVED

Inwards and forwards, across the palm, by	*Outwards & backwards by*	*Upwards & forwards, away from the other fingers, by*	*Backwards and inwards, to the other fingers, by*
Opponens pollicis	Extensor ossis metacarpi pollicis	Abductor,	Adductor
Flexor brevis	—— primi internodii	*Assisted by part of the*	Extensor primi internodii
—— longus.	—— secundi internodii.	Flexor brevis.	—— secundi internodii.

THE FINGERS ARE MOVED

Forwards, or flexed, by	*Backwards, or extended, by*	*Outwards, to radial border, by*	*Inwards by*
Flexor sublimis	Extensor communis	Abductor indicis	Abductor digiti minimi.
—— profundus	—— minimi digiti	Adductor digiti minimi	Inter-ossei.
Lumbricales	Indicator.	Inter-ossei.	
Inter-ossei			
Flexor brevis digiti minimi			
Abductor digiti minimi.			

THE THIGH IS MOVED

Forwards by	*Backwards by*	*Inwards by*	*Outwards by*
Psoas magnus	Gluteus maximus	Psoas magnus	Tensor vaginæ femoris
Iliacus	Part of gluteus medius	Iliacus	Gluteus maximus
Tensor vaginæ femoris	Pyriformis	Pectineus	——— medius
Pectineus	Obturator internus	Gracilis	——— minimus
Adductor longus	Part of adductor magnus	Adductor longus	Pyriformis.
——— brevis.	Long head of biceps	——— brevis	
	Semi-tendinosus	——— magnus	
	Semi-membranosus.	Obturator externus	
		Quadratus femoris.	

THE THIGH IS ROTATED

Inwards by	*Outwards by*
Tensor vaginæ femoris	Gluteus maximus
Part of gluteus medius,	Part of gluteus medius
And, when the leg is extended, by	Pyriformis
	Gemellus superior
	Obturator internus
Sartorius	Gemellus inferior
Semi-tendinosus.	Quadratus femoris
	Obturator externus
	Psoas magnus
	Iliacus
	Adductor longus
	——— brevis
	——— magnus
	Biceps cruris, slightly.

THE LEG IS MOVED

Backwards, or flexed, by	*Extended by*
Semi-tendinosus	Rectus
Biceps	Crureus
Semi-membranosus	Vastus externus
Gracilis	——— internus.
Sartorius	
Popliteus.	

THE FOOT IS MOVED

Forwards, or flexed, by	*Backwards, or extended, by*	*Inclined inwards by*	*Outwards by*
Tibialis anticus	Gastrocnemius	Extensor proprius pollicis	Peroneus longus
Extensor proprius pollicis	Plantaris	Flexor longus digitorum	——— brevis
——— longus digitorum	Soleus	——— pollicis	Extensor longus digitorum
Peroneus tertius.	Flexor longus digitorum	Tibialis posticus.	Peroneus tertius.
	——— pollicis		
	Tibialis posticus		
	Peroneus longus		
	——— brevis.		

THE TOES ARE MOVED

Backwards, or flexed, by	*Forwards, or extended, by*	*Inclined inwards by*	*Outwards by*
Abductor pollicis	Extensor longus digitorum	Abductor pollicis	Adductor pollicis
Flexor brevis digitorum	——— proprius pollicis	Inter-ossei.	——— digiti minimi
Abductor minimi digiti	——— brevis digitorum.		Inter-ossei.
Flexor longus pollicis			
——— digitorum			
Flexor accessorius			
Lumbricales			
Flexor brevis pollicis			
Adductor pollicis			
Flexor brevis minimi digiti			
Inter-ossei.			

CHAPTER V.

FASCIÆ.

We have here grouped together the different fasciæ, or membranous investments of parts which are of importance, more particularly those which have relation to the surgical anatomy of different regions.

CERVICAL FASCIA.

576. The neck is enclosed by a membranous investment, similar in its general conformation to those of the extremities, though not so firm in its structure. It is called the *cervical fascia*. We may observe, *in limine*, that a layer of cellular tissue lies beneath the skin, disposed in the same way as the subcutaneous cellular membrane in other situations, but which is here termed the *superficial cervical fascia*. Its chief peculiarity is, that at the sides of the neck the cutaneous muscle (platysma) is developed in its interior, dividing it into two lamellæ, but before and behind that muscle it is single and undivided, as elsewhere, being continuous superiorly with the cellular tissue on the face, and below with that on the thorax. (See Dissection of the neck, Sect. 373.)

577. The *deep*, or *proper cervical fascia*, encases the neck all round, from the ligamentum nuchæ to the middle line at the fore part of the neck, where the two lateral portions are united from the chin to the sternum. When fully exposed, by removing the platysma and superficial cellular membrane, and turning back the trapezius muscle, we find its conformation to be as follows: Commencing posteriorly at the middle line, the fascia will be found to bind down the splenius and second layer of muscles as far as the external border of the sterno-mastoid muscle. It there divides into two layers, one placed before, the other behind that muscle, and uniting again at its inner border, so as to form a sheath for its investment. From this point the fascia is prolonged, in front of the trachea and its

muscles, to the middle line, when it unites with the corresponding portion of the opposite side. Whilst passing over the muscles just referred to, it sends thin lamellæ between them, which form the cellular sheaths that enclose them, and become attached to their respective points of insertion.

If traced upwards, the lamella on the cutaneous surface of the sterno-mastoid will be found to pass over the parotid gland, and to be thence prolonged over the side of the face, becoming thin, and gradually degenerating into cellular tissue. But externally it is attached to the cartilaginous tube of the ear, and higher up to the zygoma. The deep layer inclines inwards, and becomes connected with the styloid process, from which it is again reflected to the angle of the lower jaw, forming a broad lamella, extended between these points, which constitutes a septum between the parotid and sub-maxillary glands, and is usually described as the *stylo-maxillary ligament.*

578. When examined at the lower part of the neck, the fascia will be found strained tightly across from one sterno-mastoid muscle to the other, and thence extended down to the top of the sternum, where it divides into two lamellæ, one being continued on its cutaneous, the other on its thoracic surface, where they are firmly attached. This part of the fascia may be said to complete the wall of the thorax, and to bear off the pressure of the atmosphere from the air-tubes. External to the sterno-mastoid, the superficial layer of the fascia passes over the clavicle, and is continued down, becoming thin and cellular on the pectoral muscle. But the deep-seated lamella, after having sent back a process which forms a sheath for the tendon of the omo-hyoideus, reaches the border of the subclavius, where it divides into two layers, of which one passes before, the other behind that muscle, so as to invest it. At its lower border both these unite again, and become attached to the coracoid process on the one hand, and the cartilage of the first rib on the other, forming a dense lamella in front of the subclavian vessels, and called the *costo-coracoid membrane* or *ligament.* At first sight it appears to cease at this point by a lunated border, but on closer inspection it will be found to be prolonged down over the thorax, becoming thin and cellular as it descends.

FASCIA OF THE ARM.

579. The upper extremity is invested by a fascia, or membrane, analogous in its general formation to that of the lower, though by no means so dense or firm. If examined towards the bend of the elbow, it will be found to form a complete sheath for the arm, investing it all round. In this situation the fascia is continuous with a similar investment of the fore-arm, which may thus be said to be prolonged downwards from it. The fascia is also connected intimately with the condyles of the humerus, and also with the ridges which extend upwards from them, by two membranous septa (*inter-muscular ligaments*) prolonged from its inner surface to the bone, and separating the anterior from the posterior muscles. The one on the outer side of the arm extends up to the insertion of the deltoid muscle, the other reaches to that of the coraco-brachialis. When traced upwards, the fascia becomes thin and weak where it covers the deltoid, but yet it can be easily recognised as far as the spine of the scapula, into which it may be said to be inserted. Internally, it is connected somewhat with the tendons of the pectoralis major and latissimus dorsi, and stretches across the folds of the axillary space, but gradually becomes thin, and degenerates into cellular substance, where it is prolonged towards the serratus magnus.

580. The *fascia of the fore-arm* is continuous all round with that of the upper arm, but is much more dense and firm, being composed of fibres that interlace in almost every direction. Posteriorly, it is thick and firm, and binds down the extensor muscles, being intimately connected with their fibres, as well as with the intermuscular septa placed between them; anteriorly, it covers the two groups of muscles placed on the ulnar and radial borders of the fore-arm, being at the same time stretched across that angular interval into which the brachial vessels and the tendon of the biceps sink as they proceed to their destinations. In this situation it is strengthened by a process derived from that tendon. Inferiorly it may be said to terminate by becoming inserted into the annular ligaments of the wrist (anterior and posterior).

581. The hand is also covered by a membranous investment, which on the dorsal surface is thin and weak, being prolonged

to the phalanges of the fingers from the posterior annular ligament. But that in the palm is dense and firm, and called the *palmar fascia*, being analogous to the fibrous structure which sustains the muscles in the sole of the foot. The palmar fascia, fig. 102, 5, is attached to the anterior annular ligament, where its fibres are collected into a thick and rather narrow fasciculus. As it extends over the palm of the hand, its fibres gradually diverge, so as to form rather a broad membrane. Its anterior border presents four processes, corresponding with the metacarpal bones of the fingers, and at their digital extremities each divides into two thin fasciculi, which diverge to be inserted into the lateral ligaments of the first joints of the fingers, and into the heads of the metacarpal bones. The angular interval formed by the divergence of these processes serves to transmit the flexor tendons and the digital branches of the vessels.

FASCIA LATA.

When the common integument has been dissected off and removed from the lower extremity, it will still be found invested by a membrane of a glistening white colour, close in its texture, and composed of fibres crossing in various directions. Anatomists have named it the fascia lata of the thigh. The leg is enclosed in a similar investment, and so is the foot. But each presents certain peculiarities, which require a separate consideration.

582. The *fascia lata* of the thigh may be considered as its special or immediate investment, not only enclosing it in its entire extent from the knee to the pelvis and Poupart's ligament, but also sending processes inwards in several situations, which form septa between the muscles. The thickness of this membrane varies in different parts. It is considerable along the external side of the thigh, it is less so on its posterior aspect; but superiorly, at the inner side, it is in some places so thin as to require great care in dissecting off the skin, else the fascia will be removed with it. When examined towards the lower part of the thigh, it is found to be prolonged over the knee-joint, and to be continuous with the fascia of the leg. It has at the same time a connexion more or less intimate with all the bony prominences round the articulation, viz. with the condyles

on each side, with the tuberosities of the tibia below, with the head of the fibula to the outer side, to which it is guided by the biceps muscle, and finally, after being stretched across the popliteal space, it is prolonged over the gastrocnemius muscle, and so becomes continuous with the fascia of the leg at the back part.

When traced upwards over the thigh, it is found not only to encase it, but also to send processes inwards between the muscles. The most dense and remarkable of these is one which passes in between the vastus externus and the short head of the biceps, and is attached to the linea aspera in its whole length, as far as the insertion of the gluteus maximus. Along the internal side of the thigh it invests the muscles, and merely gives attachment to some thin cellular lamellæ which lie between them; but along the course of the sartorius, particularly in the lower two-thirds of its extent, an investment or sheath is formed for it, which serves to maintain it in its place, notwithstanding the obliquity of its direction.

Its points of attachment at the superior part of the limb are so numerous, that it becomes necessary to examine each of them in detail, more especially as one portion of the membrane bears an important relation to the parts connected with Hernia. Thus, 1st, at the external and posterior sides of the limb, the fascia, after having been intimately connected with the insertion of the gluteus maximus, is prolonged backwards and upwards on the cutaneous surface of that muscle, and, though very thin and weak, it may with care still be traced as far as to the side of the sacrum and coccyx, and also to the crista of the ilium, to which it is firmly attached, after having passed over the upper part of the gluteus medius. The fascia in the latter situation becomes very dense and firm, and is intimately connected with the fibres of that muscle. Still more externally it divides into two lamellæ, which embrace the inferior termination of the tensor vaginæ femoris, to which it in this manner gives insertion. These two lamellæ become united into one along the posterior border of the muscle, which, by being prolonged over the gluteus medius, (to whose fibres it gives attachment by its inner surface,) passes to be inserted into the crista of the ilium and its spinous process. 2nd, Along the inner side of the thigh the fascia passes upwards over the adductor muscles, and becomes attached to the tuberosity of the ischium and its ramus, as well as to that of the os pubis, as far as its spinous process. 3rd, The most important part of the membrane—that which has claimed the greatest share of attention from anatomists and surgeons, remains now to be considered, namely, the part immediately below Poupart's ligament, and which extends from the spinous process of the ilium to that of the pubes.

It will be recollected that the membrane forms an uninterrupted sheath, until it comes within a little more than an inch of Poupart's ligament. There a division takes place, and an opening is established for the transmission of the superficial vessels. . The saphenous vein, in its whole course, from the inner ankle to the knee, and thence to the top of the thigh, lies superficial to the fascia. The superficial lymphatic vessels are similarly situated; the superficial epigastric vessels also descend over the abdominal muscles; and as all these converge to one point, in order to communicate with the deep-seated vessels, an opening must be established for them in the fascia lata. The existence of this opening has caused a division of the anterior portion of the fascia into two parts, one external, the other internal.

583. The *external* or *iliac* portion passes upwards, lying on a plane anterior to the vessels, and becomes attached to the lower border of Poupart's ligament, with which it continues to be thus united as far as the spinous process of the pubes. Whilst it is being prolonged in front of the femoral vessels, this part of the membrane, by reason of its inclination from below upwards and inwards, must necessarily present a curved or falciform appearance, one extremity of it being at the lower border of the saphenous opening, the other at the spinous process of the os pubis. Now, as the membrane stretches between these two points, its border becomes folded on itself, not ceasing abruptly at the margin of the opening, as at first sight may appear. On the contrary, it is reflected on itself, and the reflected part becoming very thin, and degenerating into cellular tissue, passes outwards on the sheath of the vessels with which it is identified; but towards its superior termination it turns under the border of Poupart's ligament, and adheres to that of Gimbernat, with which it is inserted into the pectineal line.

584. The *pubic* or *inner* portion of the fascia (so called from

its situation) lies on the pectineus muscle, and therefore is on a plane posterior to the femoral vessels. Superiorly, it terminates at the pectineal line, to which it is guided, as it were, by the muscle of that name; externally, it passes behind the vessels and their sheath, and, on reaching the border of the psoas muscle and its tendon, divides into two lamellæ. Of these, one, rather dense and firm, passes deeply behind the tendon, and becomes attached to the fibrous capsule of the hip-joint; the other, lying more superficially, unites, along the border of the psoas magnus, with a membrane covering the muscle just named. This cannot be the fascia iliaca, as is usually stated. That membrane extends no farther than Poupart's ligament, in all that part between the spine of the ilium and the femoral vessels. In the rest of its extent, it forms part of the sheath of these vessels, behind which the pubic part of the fascia lata lies. The membranous structure then, with which the pubic part of the fascia lata becomes blended at the border of the psoas, is a deep-seated layer of the fascia lata, prolonged upwards upon the iliacus and psoas muscles, and which finally unites with the under surface of the fascia iliaca, where the latter turns forwards to be connected with Poupart's ligament.

Now, the iliac and pubic parts of the fascia lata are continuous, and united at the lower border of the opening which their junction serves to form, and over which slides the saphenous vein. Though the fascia, in the situation here referred to, appears to present a defined, concave border (the concavity looking upwards), it still will be found not to cease abruptly; on the contrary, it is folded on itself like the external margin of the opening, and reflected down on the sheath of the vessels, on which it is gradually lost. The oval aperture here described, from its transmitting the saphenous vein, is called the *saphenous opening* (*foramen saphenum*), and its curved external margin has been named by Mr. Burns the *falciform process.*

585. *Saphenous opening.—Dissection:* The description here given of this opening, and the statements concerning the manner in which the external and inferior parts of its border are folded and reflected, may be verified by dissecting it in the following way: We shall suppose for a moment that the skin has been carefully removed from the upper part of the fascia, so as to exhibit its two parts. The opening,

however, is not defined, nor is its border distinctly seen. This is owing to the existence of a thin lamella, which is laid across the opening, and connected at each side with its borders. It is evidently of a reticular texture, and pierced by numerous small foramina, which transmit the superficial vessels; hence it is named by some persons *fascia cribriformis*. It is considered as a part of the fascia lata, which, however, cannot be the fact; for the lower border of the opening is reflected down upon the sheath of the vessels, and the external one is reflected outwards upon it, whilst the inner part is prolonged altogether behind it. Hence no part of the membrane can be extended upwards in this situation. If the saphenous vein be cut across an inch below the opening, and the fascia carefully divided by a transverse incision a little below its margin, the reflected layer can be observed as it passes down on the sheath of the vessels. Again, if from this incision another be made at right angles with it, and carried up to Poupart's ligament, the thin, reflected lamella sent outwards from what is called the falciform process, will be distinctly seen. If then, by the reflection of this border on the vessels, and the transmission of the pubic part behind them, the whole of the fascia is, as it were, accounted for, it follows that no third part remains to cover the opening, or to form what has been termed the cribriform fascia or lamella. What this really is, will appear when we shall have examined the superficial fascia; it is in fact derived from that membrane, and forms part of it. (Sect. 592.)

FASCIA OF THE LEG.

586. The lower part of the limb, from the knee to the ankle, is encased by a membrane similar in structure and use to that of the thigh. Posteriorly it is continuous with that part of the latter which covers the popliteal space; externally it contracts a firm adherence to the head of the fibula, where it is strengthened by additional fibres, given off from the biceps muscle; and internally it receives an expansion from the sartorius. If traced down from these different points, the fascia will be found to invest the muscles, and also to send processes inwards between them, more particularly between the extensor communis and tibialis anticus in front, and on the outside between the peroneal muscles. These intermuscular septa serve to increase the number of points to which the muscles are attached; for it will be observed that their fibres arise from them, as well as from the

inner surface of the fascia for some way down the leg. The fascia is thin posteriorly over the gastrocnemius, but is dense and firm where it covers the extensors, more particularly at the upper part; and will be found so firmly united along the anterior angle of the tibia, that it cannot be detached so as to be traced over its cutaneous surface. If traced along the posterior aspect of the leg, the fascia will be observed to pass over the tendo Achillis, and to be connected with the malleoli on each side, and also with the fibrous sheaths which bind down the tendons passing behind them. On the inner side it joins the internal lateral ligament, externally it is continuous with the fascia covering the side of the foot, and in front becomes identified with the anterior lamella of the anterior annular ligament.

FASCIÆ OF THE FOOT.

The fasciæ of the foot consist of two parts, differing in density and texture as well as in situation, one being a dense fibrous structure placed in the sole of the foot, the other a thin membrane covering its dorsum. Previously to examining the latter, it becomes necessary to describe a band of fibres which is strained across the bend of the ankle, and serves to bind down the tendons of the muscles.

587. The *anterior annular ligament* is attached by one extremity to the external malleolus and to the depression on the upper surface of the calcaneum, from which points the fibres of which it consists pass obliquely inwards, and divide into two fasciculi on reaching the border of the peroneus tertius and common extensor, one of them passing in front, the other behind the tendons of these muscles. At their inner border the fasciculi become united again, thus forming a tube or sheath for the transmission of the tendons. A similar arrangement of these fasciculi obtains as they cross the tendons of the extensor proprius pollicis and tibialis anticus, so that each is made to pass through a separate tube; and, finally, the fibres of the ligament, after having been thus successively separated and united again, are inserted into the internal malleolus. Now the fasciculus of this band, or ligament, which lies in front of the tendons, is continuous by its upper border with the fascia of the leg, and by the lower with that on the dorsum of the foot, all three lying on the same plane beneath the skin.

588. The *internal annular ligament* is attached, by one extremity, to the inner malleolus and to the fibrous sheath of the muscles passing behind it, by the other to the inner margin of the calcaneum. Its superior border is continuous with the fascia of the leg, the inferior gives origin to part of the abductor pollicis; one surface is subcutaneous, the other is in contact with the vessels and tendons of the flexor muscles, which pass under cover of it into the sole of the foot.

589. The *fascia on the dorsum of the foot* is a thin lamella which covers the extensor tendons, being prolonged from the lower border of the annular ligament forwards to the digital phalanges. When traced towards the external border of the foot, it is found to be attached to the head of the fifth metatarsal bone. Behind that point it becomes blended with the corresponding margin of the plantar fascia, and before it the membrane folds over the abductor and short flexor of the little toe, and unites with the digital process of the plantar fascia that lies beneath them. When traced along the inner border of the foot, we find the membrane passing over the fleshy fibres of the abductor pollicis. Posteriorly, it is attached to the calcaneum; but in all that part called the hollow of the foot, after covering the muscle just named, it is folded round its outer border, and, for part of its extent, passes deeply towards the tarsal bones, becoming blended with a septum sent upwards by the plantar fascia; farther forwards it unites with the first digital process of the fascia just named.

The examination of the fascia in this situation is easily conducted by dissecting it from the tarsal bones, and tracing it over the border and plantar surface of the abductor muscle, when its termination and attachments will be found to be as above stated.

590. The *plantar fascia* is a dense firm layer of fibrous structure, extended from the calcaneum to the heads of the metatarsal bones, along the sole of the foot. Its fibres are white and glistening; most of them are longitudinal in their direction. The transverse fibres by which these are woven into a layer increase somewhat in strength at the fore part, particularly where the digital processes are given off. The fascia is attached behind to the posterior tubercles on the plantar surface of the calcaneum, where its fibres (the greater number of which are longitudinal) are aggregated into a narrow, thick fasciculus. From

this point the fibres, as they proceed forwards, diverge and arrange themselves into two parts, separated by a depressed interval, one corresponding with the muscles of the little toe, the other with the middle of the tarsus and the whole width of the metatarsus. The external, or narrow part, after being connected firmly with the fifth metatarsal bone, sends forwards some thin fibres which unite with the last digital process of the larger portion. By its outer border it gives attachment to the fascia of the dorsum of the foot; from the inner it sends a process upwards to the tarsal bones, which contributes to form a septum between the plantar muscles. The broad portion of the fascia becomes thin as its fibres diverge, and ultimately resolves itself into five processes corresponding with the metatarsal bones. Each process, on reaching the digital extremity of these bones, divides into two fasciculi, which separate and become attached to their sides, and to the lateral ligaments, thus leaving an angular interval for the transmission of the flexor tendons and the vessels to the phalanges of the toes. From each border of this part of the fascia a membranous partition is given off, which separates the mass of muscles placed in the middle of the foot from those which are situated along its borders, and belong to the great and little toes. These septa are not merely interposed between the lateral and middle bundles of muscles;—a thin fascia will be found passing across from one to the other, separating the three superficial muscles from those which are deeper seated, and at the same time combining, with the septa at the sides and the plantar fascia beneath, to form a sort of sheath for each of the three muscles alluded to.

If the middle or broader portion of the fascia be divided by an incision carried from behind forwards, and the two parts reflected to each side off the flexor brevis, the septa will be observed passing upwards; and if that muscle be drawn aside, the *deep fascia* will come into view.

It may be proper to observe, that the plantar fascia is usually said to consist of three portions, the lamella which covers the great toe being considered as one. But this will be found, if examined in the way already pointed out (589), to be a prolongation from the fascia on the dorsum of the foot, to which its structure is strictly analogous, and therefore altogether different from that of the plantar fascia.

ABDOMINO-INGUINAL REGION—SURGICAL ANATOMY OF.

591. The muscular parietes of the abdomen, it will be recollected, consist of three lamellæ at each side, placed one over the other. The arrangement of their fibres, in the greater part of their extent, is well calculated to support the viscera, and prevent their protrusion. The external set incline downwards and inwards, those subjacent to them run in the opposite direction, whilst the internal ones take a transverse course; so that they afford to each other a mutual support.

But this arrangement does not obtain throughout the entire extent of these muscles. At the lower part of the abdomen, in the part generally known as the "inguinal region," or "abdomino-inguinal," (meaning thereby the part just above Poupart's ligament,) the fibres of the muscles are quite differently disposed; they all incline downwards and inwards, and thus lose the advantage obtained by the arrangement above noticed. The fibres also of the two inner muscles, in this part, are thin and pale, and, moreover, an interstice exists beneath their lower border for the passage of the spermatic cord of the male, and the round ligament of the female. In the external muscle, also, an aperture is formed for the transmission of the same parts. Again; Poupart's ligament being merely stretched across from the spinous process of the ilium to the os pubis, can only be contiguous to, or in apposition with, the parts which pass beneath it from the abdomen down to the thigh, viz. the psoas and iliacus muscles and the femoral vessels. These are obviously so many sources of weakness—so many deficiencies in the structure of the part, which, if not guarded against by some additional provision, would leave us constantly exposed to the occurrence of intestinal protrusions both above Poupart's ligament and below it. Such a provision appears to be made by means of a lining, which is placed at the inside of the abdominal muscles; but its description can be more conveniently given farther on (sect. 592), as we here take the different textures found in the inguinal region as they present themselves, layer after layer, in our everyday examinations of them.

Dissection.—Make an incision through the skin directly inwards from the anterior superior spine of the ilium to the middle line of the body (linea alba); carry another thence down to the pubes.—Reflect this angular flap of tegument down upon the thigh, without disturbing the loose cellular layer beneath it. This is called the superficial fascia—it requires a detailed notice.

592. The *superficial fascia* (fascia superficialis) is a layer of cellular membrane placed between the skin and the external oblique muscles in their entire extent, and which is moreover prolonged upwards over the thorax, down on the thighs, and backwards into the loins. It is in fact part of the subcutaneous cellular membrane which we find all over the body; but in the region here referred to, it deserves particular attention, from its forming one of the coverings of hernial tumours. In the human subject it can add little to the strength of the abdominal parietes; but in animals, particularly in the larger quadrupeds, its place is occupied by a membrane of a yellow colour, firm texture, and quite elastic, which assists the muscles materially in supporting the viscera. Its structure in these cases is analogous to that of the ligamenta subflava of the vertebræ, or to the middle coat of arteries, according to the opinion of those who deny their muscularity.

Dissection.—The superficial fascia increases in thickness towards the lower part of the abdomen, and in its substance may be observed to run the superficial epigastric vein and artery, so that along their course it may, by a little care, be separated into two layers, one being behind, the other before these vessels; but on each side of the vessels it remains single and undivided. Taking the vessels as a guide, the anterior layer of the fascia can be dissected off them as far down as the saphenous opening in the fascia lata, and thence downwards uninterruptedly over the thigh. Externally, where the membrane is undivided, it can be traced over the iliac part of the fascia lata, and internally over the spermatic cord, and so to the scrotum, forming one of its layers, and thence down into the perinæum. When raised from the aponeurosis of the external oblique muscle, and reflected down, together with the small vessels which lie upon it, we find it closely connected by cellular bands with the line of junction between the iliac portion of the fascia lata and Poupart's ligament, and further down it becomes connected with the borders of the saphenous opening,—that layer of it which lies behind the vessels being stretched across from one border to the other, so as to form the *cribriform fascia* or *lamella* through which the superficial vessels pass, and which, for the reasons already stated when describing the fascia lata, cannot be considered as a part of that membrane. (Sect. 585.)

593. The *aponeurosis* of the external oblique muscle being exposed by the removal of the superficial fascia, the fibres which compose it will be observed gradually to separate as they approach the crista of the os pubis, and to be aggregated into two bundles, leaving an interval between them, as they pass, the one to the symphysis pubis, the other to its tuberosity. This interval must therefore be of a triangular form, its base corresponding with the crista of the os pubis, and the sides with the two bundles of fibres above referred to. This has been called the *external abdominal ring*,—a term evidently ill-chosen, if its form be considered, more particularly as its bounding lines are named *pillars*. Towards the crista of the os pubis a rounded cord (*spermatic*) projects through the opening, but its borders or pillars are not distinctly defined, which is owing to the circumstance of a membrane being stretched across from one to the other, and also prolonged on the cord.

594. *Inter-columnar fascia.*—If the surface of the aponeurosis of the external oblique be examined, a series of fibres will be observed running upon it and describing arches, the convexities of which look downwards and inwards. As they approach the triangular aperture they become more closely aggregated together, and lose their fibrous character, so as to assume that of a smooth membrane, which passes thence downwards on the cord, forming one of its investments. Whilst resting on the fibres of the muscle, this structure is called the "inter-columnar fascia," and where it comes into contact with the cord it receives the name of *fascia of the cord*, or *fascia spermatica.*

In order to exhibit clearly the margins or "pillars" of the ring, this thin fascia may be detached from the cord by holding the cord forwards, and lightly drawing the edge of the scalpel all round it, so as to divide the fascia, after which it can be readily pushed upwards.

Dissection.—The aponeurosis of the external oblique muscle may, in the next place, be divided by an incision carried horizontally inwards from the anterior superior spine of the ilium to the linea alba, from the termination of which another should be drawn down to the pubes. The angular flap thus included may then be reflected down on the thigh, by which means the internal oblique muscle is brought into view, and also the cremaster, which is given off from its lower border, and thence prolonged upon the cord, with which it passes through the opening in the external oblique muscle. The cord lying undisturbed in its situation, will be observed to rest (so far as it is exposed by reflecting the external oblique) upon the fibres of the internal oblique, after having passed beneath its lower border. For the same extent it is covered by the aponeurosis of the external oblique, and inferiorly it is supported by the groove formed by the lower fibres of the latter, as they turn obliquely backwards and inwards to reach their second and third insertions. Supported in this groove to the point at which it passes through the external ring, the cord will be observed to incline a little outwards after its exit, and to lie to the outside of the tuberosity of the os pubis.

The next step is to *expose the cord in the rest of its extent;* to effect which it becomes necessary to detach the fibres of the internal oblique muscle from the inner surface of Poupart's ligament, and to draw them inwards, together with the cremaster, towards the middle line. This requires to be done with care, in order to separate them from the transversalis muscle, whose fibres in this part run in the same course, both being also inseparably united previously to their insertion into the crista of the os pubis. When this is effected, the cord will be found to pass beneath the lower fibres of the transversalis muscle, where they form an arched border over it; and if these fibres be carefully pushed upwards, by passing the handle of a scalpel beneath them, a thin membrane will be brought into view, on which the muscle last named rests. Through this membrane the cord passes; in doing so, however, it does not pass through it as it might be supposed to do through a hole in a sheet of paper, or, in other words, through an aperture with a sharp and defined border. On the contrary, the cord in its passage carries with it, from the margin of the opening, a prolongation which runs down upon it, enclosing it all round, and gradually narrowing so as to become of a funnel-shape.

Now, if the fibres of the transversalis muscle be detached a little farther, an artery (the epigastric) will be observed running from below upwards, lying to the inner side of the cord, at the point where the latter pierces the membrane. This, it may now be observed, is called the *fascia transversalis,* from lying behind the muscle of that name, and forms part of a general lining placed within the abdominal parietes.

595. *Inguinal canal:*—The spermatic cord, then, in its passage, lies in an oblique canal (inguinal) formed for it in the wall of the abdomen; it presents an inlet, an outlet, and an intervening space, viz. the canal itself, each of which requires a special notice.

Abdominal ring—internal:—The inlet, or inner aperture of the canal, is called "the internal abdominal ring;" it is situated in the fascia transversalis, being that part of it through which the cord passes as it is about to emerge from the cavity of the abdomen. It corresponds with the middle point between the anterior superior spinous process of the ilium and the symphysis pubis, being about half an inch above the margin of Poupart's ligament. Its existence may be determined, and its margins defined, or rather margins may be given to it, by holding the cord forwards, and cutting across the prolongation which it receives from the fascia. When the cord is relaxed, the aperture becomes apparent.

Abdominal ring—external:—The outlet, or the inferior and external opening, fig. 99, 10, is called "the external abdominal ring;" it is the triangular interval left between the fibres of the external oblique muscle, which has been already described (593).

The *inguinal canal* is the interval between the two apertures here noticed, its direction being downwards, inwards, and a little forwards. Its length may be said to be from an inch and a half to two inches; as it varies in different instances, being greater in the female than in the male subject, and in adult age than in infancy. To understand rightly the nature of this canal, and the structures in which it may be said to be formed, we must consider the course of the spermatic vessels in their progress from the abdomen down to the scrotum, and the relations which they bear successively to the fascia transversalis, and the transversalis muscle,—to the internal oblique muscle and also to the external oblique; for these are placed and adjusted in a manner so peculiar, that the vessels in passing to their destination bear to each a special relation in the different parts of their course. How they are made in this short interval to pass through, beneath, upon, and between the contiguous surfaces and borders of the structures above named is shown in the next paragraph.

596. *Spermatic cord—its coverings and relations:*—At the

point above indicated, viz. midway between the anterior superior spine of the ilium and the pubic symphysis, the spermatic vessels and the vas deferens meet at an angle. They there pass *through* the fascia transversalis, as has been already stated, and receive from it their first investment, viz. the funnel-shaped process given off from the margin of the internal ring. Thus enclosed, they turn downwards and inwards, under cover of the transversalis muscle, and then under the internal oblique. During this part of its course, which is about one-third of the length of the canal, the cord rests *upon* the fascia transversalis, and is covered immediately by the muscles just mentioned. It then passes *beneath* the lower border of the internal oblique muscle, and receives its second covering, viz. the cremaster; and during the rest of its course it lies *between* the contiguous surfaces of the internal and external oblique muscles. For it rests upon the conjoined fibres of the internal oblique and transversalis muscles (where they turn down to be inserted into the crista of the os pubis and the pectineal line), and is covered by the aponeurosis of the external oblique. Finally, it passes through the external ring, where its third investment is placed upon it, viz. the inter-columnar fascia, or fascia of the cord, after which it becomes covered by the superficial fascia and the common integument.

These different structures are examined with attention by anatomists, not so much from a consideration of any importance or interest they possess in the natural or healthy condition of the parts, but in consequence of the relation which they bear to hernial tumours when they occur in this situation. Five lamellæ, it will be recollected, have been here enumerated as forming the investments of the cord. They have been taken in the order in which the cord and testis come into contact with them whilst passing from the abdomen down into the scrotum. Should a portion of intestine be forced through the internal ring into the canal, and so down into the groin, it will, during its progress, clothe itself in these same investments, having previously derived another from the peritonæum, which it pushes before it at the moment of its exit. Hence it is that the anatomist describes these structures in the order in which they are super-imposed upon the cord or hernial sac; the surgeon, on the other hand, enumerates them in the order in which they successively present themselves to his scalpel whilst he is dividing them during an operation.

597. *Oblique inguinal Hernia—situation of:*—When the intestine follows the course of the spermatic cord through the inguinal canal, the tumour which it forms is denominated, from its situation and direction, " oblique inguinal hernia." In such cases, the neck of the hernial sac lies close to the external side of the epigastric artery, on which account Hesselbach has applied the term " hernia externa" to that form of the affection now under consideration.

598. *Direct inguinal Hernia—situation of:*—At the inner side of the epigastric artery a *triangular space* will be observed, its sides being formed by that vessel and the external border of the rectus muscle, and its base by the crista of the os pubis and the part of Poupart's ligament intercepted between its tuberosity and the epigastric artery. Should the intestine protrude in this situation, it must either distend and push before it the conjoined fibres of the transversalis and internal oblique muscles, or it may rupture some of them, and escape through the interval. In either case it passes directly forwards through the external ring, and hence has been denominated *direct inguinal hernia.* But Hesselbach calls it *hernia interna*, from its relation to the epigastric artery.

Dissection.—Across the area of this space are stretched the conjoined fibres of the internal oblique and transversalis muscles, which, even with the addition of the fascia transversalis, would form an inadequate support to the viscera in this situation, particularly as the external oblique cannot lie evenly upon them, owing to the interposition of the cord. By a little attention a number of white tendinous fibres may be observed to pass obliquely upwards and inwards from about the inner fourth of Poupart's ligament, as well as from the crista of the os pubis; and after crossing the area of the triangular space, to terminate by being inserted into the linea alba. These by being stretched between the points just referred to, and by running across the fibres of the internal oblique and transversalis muscles, with which they are in close contact, tend materially to support them. But this is not the only influence they seem to exert. If the fibres of the external oblique be cut through, so that no part be allowed to remain but the external pillar of the ring and Poupart's ligament, it is clear that no direct communication any longer exists between the latter and the linea alba. Now if the linea alba be pushed to the opposite side, or if it be cut across and drawn in different directions, by being held in the forceps, Poupart's ligament will be made tense and elevated by the traction exerted upon it through the medium of the oblique fibres here described. These fibres, then, serve not only to strengthen the part over which they are extended, but also to connect the linea alba and Poupart's ligament, somewhat on the principle of a diagonal brace, and by means of their elasticity tend to weaken the force of any pressure made upon the part by diffusing it over a greater extent of surface.

A correct and clear knowledge of the direction and formation of the inguinal canal can alone enable the surgeon to apply the taxis judiciously in cases of oblique hernia. And a knowledge of the precise situation of the internal ring is no less necessary to point out the exact spot on which the pad of a truss should be applied to prevent the recurrence of a hernial protrusion.

FEMORO-INGUINAL REGION.

The groin or inguinal region is divisible into two parts —the division being established by the line of Poupart's ligament. The portion above the ligament may be called the "abdomino-inguinal" region. It is the seat of the oblique and direct forms of hernia, as well as that peculiar variety of the former which occurs in infancy, and is thence termed "congenital" hernia. Now the space just below Poupart's ligament,—that which intervenes between it and the saphenous opening in the fascia lata, may be named the "femoro-inguinal region." It is the seat of that form of hernia which so frequently occurs in females, and which is usually called "femoral" from its protrudding at the top of the thigh.

599. *Dissection.*—After having examined all that part of the inguinal region which lies above Poupart's ligament, reflect the skin down from the front of the thigh for about four or five inches—reflect the superficial fascia also, and accurately define the saphenous opening. In the next place, separate the iliac portion of the fascia lata from the lower margin of Poupart's ligament by an incision carried from without inwards, and draw it down. The lower border of the ligament may in the next place be defined by passing the handle of a scalpel beneath it, and then a funnel-shaped membranous tube will be observed pass-

ing down behind it, narrowing as it descends, and investing the femoral vessels. If some of the superficial inguinal glands have been retained, their vasa efferentia may be readily seen (by drawing the glands down, so as to render the vessels tense) to pierce the inner side of the tube, and render it cribriform. This tube, by a little care, can be insulated from Poupart's ligament, which lies before it, from the border of Gimbernat's ligament, which is situated at its inner side, and from the pubic portion of the fascia lata, on which it rests; and if it, together with the enclosed vessels, be cut across two inches below Poupart's ligament, they may easily be drawn up towards the abdomen. These facts bear materially on the anatomy of the parts connected with femoral hernia.

When the examination has been conducted thus far, lay open the abdomen by making an incision from the umbilicus to the anterior superior spine of the ilium, and another down to the pubes, then draw the flap down on the thigh. The intestines should, in the next place, be removed, and the peritonæum carefully detached from the iliac fossa, and from the inner surface of the flap above described, as well as from the lumbar region.

Cellulo-fibrous lining—general idea of:—When these measures have been taken, the inner surface of the parietes of the abdomen will be found to be lined throughout its entire extent by a smooth shining membrane, which appears to be placed there for the purpose of strengthening them where they are most in need of support, and of connecting them together where, from the fact of their being merely contiguous, they are liable to be separated from each other, and so leave spaces into which the intestines may be protruded. This membrane is exceedingly thin at the upper part of the abdomen, where it may be said to degenerate into mere cellular tissue, but it gradually becomes more dense towards the lower part—in the inguinal region, and is very firm and resisting where it rests on the iliacus muscle. Its *structure* may be said to be *cellulo-fibrous;* its external surface is in intimate contact and even union with the muscular parietes of the abdomen, whilst the inner one is in apposition with the serous investment (peritonæum) of the viscera.

At a first inspection, this cellulo-fibrous lining would appear to form a cul-de-sac, its closed extremity being placed at the lower part of the cavity—one side of it being prolonged upwards behind the transversalis muscle, the other backwards upon the iliacus, the juncture or seam marking the union of the two being at Poupart's ligament. However, when examined with attention, it will be found not to form a complete shut sac at the lower part of the abdomen, for a prolongation of a tubular form descends from it round the femoral vessels, so as to become continuous with the sheath which invests them in the rest of their extent. Again, where the spermatic vessels pass from the abdomen into the inguinal canal, they also receive a tubular investment, which accompanies them. Both these, it will be recollected, have been brought into view during the progress of the dissections already directed.

Cellulo-fibrous lining—its division into parts:—The membranous lining is not usually described in this way as a continuous whole. Its different parts are examined separately and with much detail, so that students are apt to regard them as distinct structures, and probably intended for different purposes, more especially as each has been designated by a particular name. For instance, all that part of the membrane which lies above Poupart's ligament, and lines the transversalis muscle, has been from this circumstance named the *fascia transversalis.* The posterior part, which rests on the iliacus muscle, has been, doubtless for a similar reason, called the *fascia iliaca;* and where the membrane is prolonged over the margin of the pelvis it receives the name of *fascia pelvica.* Finally, where it becomes reflected upon the sides of the rectum and bladder, some have gone so far as to call it the *vesical fascia.* These, it may be observed, are anatomical or topographical names taken from the situation of the different parts of the membrane. There are others, however, which have a surgical origin (if such an expression be allowable), inasmuch as they are derived from their connexion with pathological conditions of the parts, or, in other words, with certain forms of hernia. Thus the tubular prolongation, already noticed as descending with the femoral vessels, has been termed the *fascia propria* of femoral hernia; and that which passes along the spermatic cord has been by some considered as the *fascia propria* of inguinal hernia. With this general view of that structure, which we have here ventured to term the membranous lining of the abdominal parietes, we proceed to describe, *seriatim et singulatim,* the different portions into which it is usually divided.

600. The *fascia transversalis* has been so called by Sir Astley Cooper (who discovered it), from its being placed behind the transversalis muscle, which it lines. Some degree of confusion occasionally arises from the use of this term. For whilst describing the different parts of this region, we are obliged to speak of the transversalis muscle —the conjoined fibres of the transversalis and internal oblique—the aponeurosis of the transversalis, and, finally, of the fascia transversalis. The repeated use of the same term, in so many different acceptations,

produces no small degree of perplexity, particularly to students at the commencement of their pursuits. We may then take one step at least towards removing a source of embarrassment to ourselves, at the same time that we make a due acknowledgment to the individual whose researches have thrown so much light on the anatomical structure of the parts connected with hernia; and as he was the first who discovered and described the membrane now under consideration, it may with great propriety be called *fascia Cooperi*. The fascia transversalis, or fascia Cooperi, then, is a thin smooth membrane, closely adhering to the transversalis muscle; along whose inner surface it may be traced, in many instances, upwards, as far as the margin of the ribs, gradually becoming thinner as it ascends above the umbilicus; downwards it reaches to Poupart's ligament and the pubic symphysis, and outwards it extends to the crista ilii (to which it is firmly attached). Finally, if examined above this point of bone, it will be found prolonged deeply into the lumbar region, where it gradually degenerates into cellular tissue. As the membrane extends inwards to the middle line (for we here confine our attention to one lateral half of it), it becomes closely adherent to the aponeurosis of the transversalis muscle, and where it lies behind the rectus it becomes thin and weak. If from this point it be traced downwards, it will be found, after lining the rectus, to pass along the inner surface of the pubic symphysis, and thence down to the point at which the urethra escapes from the pelvis, where it is reflected backwards upon the upper surface of the neck of the bladder, on which it is gradually lost. Along the lower border of the abdomen the membrane may be said to terminate at Poupart's ligament, at least in all that part of its extent which is included between the anterior superior spine of the ilium and the exit of the vessels, where, by uniting with the fascia iliaca, it forms a complete cul-de-sac, the junction being indicated by a white line running from without inwards; but this does not exactly correspond with the margin of Poupart's ligament. Now in the space which is included between the external border of the femoral artery and the base of Gimbernat's ligament, the membrane cannot pass backwards to join the fascia iliaca, inasmuch as the vessels are interposed between them. Hence it is prolonged down behind Poupart's ligament, guided as it were by the vessels, and forms the anterior half of the membranous tube that invests them, and which has been already more than once alluded to.

It will be recollected that the fascia transversalis forms the entire of the tubular prolongation that invests the spermatic vessels, as they escape through the internal ring. When describing the last-named opening, no mention has been made of its boundaries, or its pillars, as they have been called. It is difficult to conceive the existence of anything so dense or defined as to resemble a pillar, in a membrane so thin and uniform in its structure. Most probably a consideration of the structure of the external ring led to the idea that it was necessary to institute an analogy between it and the internal one, and so to assign pillars to the one as well as to the other; however, taking it to be elliptical in its form, its long diameter being from above downwards, it will be found that it is more dense and firm along the inner segment of the ellipsis than at the external one.

601. The *fascia iliaca* is more dense and firm than the membrane just described. It is in close contact with the iliacus muscle, and, like it, is attached to the inner margin of the crista ilii from the anterior superior spine backwards for three-fourths of its extent, and so far it is continuous with the fascia transversalis, which has been described as being inserted along that line. When traced inwards, it is found to pass behind the iliac vessels and over the psoas muscle, along the inner border of which it sinks into the pelvis. Round the margin of this cavity the fascia becomes closely connected to the bone by means of dense cellular fibres; after which it descends, lying upon the inner surface of the obturator internus muscle, until it comes to a level with an oblique line extended from the symphysis pubis to the spine of the ischium. At the point here indicated the fascia turns inwards, guided by the pelvic surface of the levator ani muscle, and so reaches the side of the rectum and bladder, with which it becomes identified. In the interval between the spine of the ischium and the promontory of the sacrum, the fascia stretches across the great sciatic notch, covering over the parts which escape through it; and as it lies behind the internal iliac artery, it is pierced by its different branches, giving to each a tubular prolongation. On reaching the surface of the sacrum the fascia becomes continuous with that of the opposite side.

It may thus be observed that the psoas muscle is covered by the fascia as well as the iliacus. We have as yet traced it upon the former no higher than where it is on a line with the crista ilii. But the fascia does not cease at this point; it extends upwards on the psoas muscle, being prolonged, from its surface, inwards upon the lumbar vertebræ, whilst, along its external border, it is united with the anterior lamella of the lumbar aponeurosis of the transversalis muscle, and terminates superiorly by being inserted into the ligamentum arcuatum proprium. Thus we find that the numerous interstices, apertures, and foramina, which occur in this extensive region, are covered over by this membrane. We now proceed to examine that part of it which is more immediately connected with the anatomy of femoral hernia.

FEMORO-INGUINAL REGION—SURGICAL ANATOMY OF.

602. When traced to the lower part of the iliac fossa, the fascia iliaca is found to turn forwards a little, and to become blended with the fascia transversalis in all that part of its extent which intervenes between the superior spine of the ilium and the exit of the femoral vessels. But in the interval between this point and the base of Gimbernat's ligament the fascia cannot come forwards so as to form a junction with the fascia transversalis, in consequence of the interposition of the vessels; on which account it passes down behind them, forming the posterior part of their funnel-shaped sheath. Now, having already derived the part of this membranous tube or sheath that lies before the vessels from the fascia transversalis, and that which is behind them from the fascia iliaca, it remains only to add, that, in order to complete the tube, the membranes unite externally along the side of the artery, and internally at the base of Gimbernat's ligament. The tube is wide above, but gradually narrows as it descends. The external border runs straight downwards along the artery, to which it is closely applied; the internal one inclines obliquely downwards and outwards, from the base of Gimbernat's ligament, so as to reach the vessels. The external part of it only is thus found occupied by the vessels, the remainder is unoccupied (except by lymphatic glands), and presents an oval opening called the *femoral ring*, which is the only outlet that exists behind Poupart's ligament through which a portion of intestine can be protruded. Such an accident cannot happen immediately in front of the vessels; for we find interposed between them, and connecting the anterior to the posterior sides of the tube, a firm process of membrane preventing their separation. Moreover, the sub-serous cellular tissue, which lies upon the iliac vessels in their entire course, becomes dense and firm near their exit, as it is being reflected from them to the anterior wall of the abdomen.

603. *Femoral arch.*—It may here be observed that the term *femoral arch* is applied to the whole space between the anterior superior spine of the ilium and the angle of the os pubis, its

boundaries being the irregularly curved border of the os innominatum, and Poupart's ligament, which stretches across it. Through this space pass the psoas and iliacus muscles, the femoral vessels and nerves, which, with the peculiar arrangement of the membranes above described, effectually prevent the protrusion of a hernia between the spine of the ilium and the femoral vein:—

Femoral ring.—But such an occurrence may happen to the inside of that vessel, the intestine passing into the femoral ring, whose boundaries (bearing in mind that it is lined by the membranous sheath above described) may be thus enumerated: anteriorly it is bounded by Poupart's ligament, posteriorly by the os pubis, internally by the base of Gimbernat's ligament, and externally by the femoral vein.

Femoral canal.—This ring forms the inlet to a canal whose outlet is the saphenous opening in the fascia lata, and through which the intestine descends, behind Poupart's ligament, into the upper part of the thigh, constituting *femoral hernia.* The ring does not at first distinctly appear, even after the removal of the peritonæum, as its margin is still obscured by a layer of the sub-serous cellular tissue, which in this situation is rather thick and dense; this, however, can be readily removed.

It may not be altogether out of place to observe that we are constantly in the practice of using the word *crural* as if it were synonymous with *femoral*, when treating of the different structures here noticed. We say crural ring—crural arch—crural nerve — crural hernia — which necessarily produces not a little confusion, as crus means the leg, not the thigh, and is synonymous with *κνημη*, tibia.

The relation of the vessels to the ring requires to be attentively considered. The external iliac vein and artery lie to the outside of the ring, and therefore of a hernial sac, should it occupy that situation. The epigastric artery, arising from the iliac, runs obliquely along the external border of the femoral ring, and must bear the same relation to a hernial tumour. Continuing to ascend, this vessel lies to the inner side of the spermatic artery and vas deferens, and therefore will be similarly placed with regard to the neck of an oblique inguinal hernia. When the obturator artery arises from the epigastric, which is not an unusual occurrence, it passes downwards and inwards into the pelvis. If it arises by a common trunk with the epigastric, or starts from that vessel close to its commencement, its course, as it descends, will lie obliquely along the lower half of the external border of the ring. In such a case this aperture, if viewed from within, the vessels having been injected, will present the form of an ellipse, its greater diameter being from before backwards, the external side being formed by the two arteries diverging to their destinations, and the internal one by the curved base of Gimbernat's ligament. But should the obturator artery arise from the epigastric higher up, its direction will then correspond with the superior and inner border of the ring, which will therefore be nearly surrounded by vessels. This, however, is a rare occurrence.

DIFFERENT FORMS OF HERNIA.

604. Having thus examined the disposition and mutual relations of the different structures of which the abdominal parietes are composed, we proceed to make a few remarks on the practical application that may be made of the facts which we have here reviewed in detail. We shall suppose that the subject lies on the table, and that the different processes of dissection above pointed out have been conducted on one side, the other remaining untouched. It may in the first place be observed, that if a hernial tumour has occurred towards the lower part of the abdomen, the intestine must have escaped either immediately above Poupart's ligament, or below it. In the former case it is termed *inguinal hernia,* in the latter *femoral.* It must obviously be a matter of the first consequence to determine this point with certainty, and without any delay; for on it depends, not only the success of the efforts made to reduce the hernia by what is called the taxis, but also the propriety and manner of performing every step of the operation requisite for the relief of a strangulated intestine, from the first incision through the skin to its final completion. This question can be determined only by ascertaining with accuracy the position of the neck of the tumour, and then carefully tracing out its relation of place, or its position with regard to Poupart's ligament. If the tumour be of moderate size, so that the finger may be passed along the ligament, from the tuberosity of the pubes outwards, little doubt can remain as to whether it lies below or above its border. But a large inguinal hernia will obscure this part by its descent, and a large femoral one by its ascent; for when the latter has passed down for some way, it turns up towards the abdomen, lying on Poupart's liga-

ment, and so occupies the situation of the other species. But if such a tumour can be drawn down a little, by making it slide between the skin and fascia, its point of attachment can at once be determined. And if, in the other form of the disease, the tumour be pushed a little upwards and inwards, so that the situation of its neck can be ascertained, and the ligament defined, as above suggested, a satisfactory conclusion will at once be arrived at. Suppose it to be decided that the tumour lies above Poupart's ligament, and therefore that it is an inguinal hernia, we have seen that its descent may be along the course of the inguinal canal, or it may pass straight forwards through the external ring,—constituting, in the former case, an *oblique,*—in the latter, a *direct inguinal* hernia. It is indispensably necessary, as well in reference to the taxis as to the operation, to distinguish even these, though so closely allied. The situation of the spermatic cord, the direction of the tumour, and also its form, furnish sufficient data on which the diagnosis may be established. In the oblique hernia, the tumour inclines upwards and outwards, in the direction of the spine of the ilium, the vas deferens, and the spermatic vessels lying behind it. In the direct descent, the tumour may be traced upwards in the direction of the umbilicus, and the cord will be found to its external side, and partly in front of it.

605. The *taxis—principle of.*—Now, if the previous question here raised be determined, and if the case has been decided to be an oblique inguinal hernia, it remains for the surgeon to restore the intestine, by the taxis, if possible; if not, by an operation. Previously to making any effort at reduction, the abdominal muscles should be relaxed as much as possible, which can be done by approximating their points of attachment. With this view, the body being placed in the recumbent posture, the shoulders should be raised and supported, and the thighs bent on the pelvis, that of the affected side being also inclined a little inwards to lessen the tension exerted on Poupart's ligament by the iliac portion of the fascia lata. So far, a knowledge of the anatomical connexion of the parts points out the propriety of placing the body and the limbs in a particular position, rather than in any other. In the next place, the tumour being taken hold of steadily with one hand, and elevated somewhat towards the ring, compression should be made on its neck with the first two fingers and thumb of the other, followed by an effort to push it upwards and outwards, that is to say, in the direction of the inguinal canal. These measures should be employed until hopes of success fail, or until it is no longer safe to continue them, from their tendency to excite or increase inflammation

in parts placed under circumstances which dispose them to run very speedily into that condition.

Operation.—When all efforts at reduction prove fruitless, the operation must necessarily be resorted to, and the sooner it is done the better. When placed on the operation table, the shoulders should be raised in the same way as whilst the taxis was being performed, but the legs must be allowed to hang over the margin of the table. In the first place, the skin may be made tense over the tumour, by straining it between the fore-finger and thumb of the left hand, if the tumour be small; or, if it be large, by supporting it in the palm of the hand, and drawing the skin from behind. The integument may then be divided by an incision drawn over the convexity of the tumour, beginning at its upper extremity, or even a little above it, and continued down to the lower, unless it be very large. Another mode of making the first incision is, by pinching up the skin into a fold, running transversely with regard to the tumour, and dividing it down to its base, or point of reflection. When this is done, and the skin is allowed to return to its original position, the line of the incision through it will be found to correspond with the direction of the tumour. This incision will divide the skin and superficial fascia, and also a small vessel, which sometimes requires to be secured, viz. the superficial or external pudic artery. The fascia of the cord becomes by these means exposed, a small piece of which should be pinched up between the blades of the forceps, and cut off close to their points, so as to make an aperture barely sufficient to admit the director. The instrument being passed upwards to the ring, the fascia is to be divided upon it by running the scalpel along its groove, and then downwards to the extent of the external incision. The cremaster is thus brought into view, and is to be divided with equal caution, and after the same manner. The hernial sac, however, is not yet laid bare; it remains covered by the prolongation given off from the margin of the internal ring, and by what we have already alluded to as the sub-serous cellular tissue, and which, as it descends, gradually becomes thin and weak. This "must be cautiously cut through," by employing the forceps, director, and scalpel, as above stated, and so the peritonæal investment, or the proper hernial sac, is exposed; to open which requires "the utmost caution." The operator should "nip up a small portion of the membrane, over the inferior and anterior part of the tumour, between the fore-finger and thumb of his left hand, and then, by gently rolling it between them, he easily distinguishes if any intestine be included: if so, he raises a fresh portion."* The slight rotatory motion of the fingers here directed will in most cases suffice to insulate the membrane from the intestine; and when this is done, the fold compressed between the fingers may be divided by the scalpel, or scissors, so as to make a small opening for the admission of the director. Whilst the director is being introduced and passed up towards the ring, its grooved border should be carefully kept in close apposition with the inner surface of the sac, lest by any means a part of the intestine should insinuate itself between them, and be divided, as the scalpel runs along the groove.

The stricture—its divisions.—It now only remains, so far as the operative part is concerned, to ascertain the seat of the stricture, and to divide it. For this purpose the fore-finger of the left hand is passed into the hernial sac, to the point at which it becomes constricted, which will be found in one or other of the three following situations, and may be stated in the order of their frequency as follows: 1. At the internal ring in the neck of the sac; 2. In the canal itself, about an inch or a little more within the external ring, the compression being formed by the lower border of the internal oblique and transversalis muscles, where they arch over the neck of the tumour; 3. At the external ring, which is less frequent than the others. The finger having reached the strictured part, a probe-pointed bistoury is to be passed along it, its side resting on the palmar surface of the finger; and when it has been conducted beneath the stricture, the edge should be turned forwards, "so that the division of the stricture should be made in a direction parallel with the linea alba, that is to say, *directly upwards.*"

Precautions.—In performing this part of the operation, the only thing to be apprehended is the division of the epigastric artery. It will be recollected that this vessel lies to the inside of the neck of the tumour in cases of oblique inguinal hernia, and on the outside in the direct hernia. If the diagnosis, in a given case, were so clear as to leave no room for doubting whether the descent was oblique or direct, the position of the artery would at once be determined with regard to the neck of the tumour, and the direction in which the stricture should be divided may be indicated with certainty. In the oblique form, the artery may be effectually avoided by cutting outwards; in the direct, by inclining the incision inwards, and in recent cases doubts seldom arise on the question. But when a hernia has been of long standing, the weight of the tumour, by drawing on its neck, and therefore on the internal ring, approximates it to the external one, by which means it occupies the situation of a direct hernia. If, on examination, such a case were pronounced to be a direct descent, and if, on such an assumption, the incision were made inwards, the artery must be divided. Such an occurrence can only be avoided by adopting the precept laid down by Sir Astley Cooper, viz. of cutting upwards in all cases of inguinal hernia, whether they be direct or oblique.

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* Sir Astley Cooper's Lectures, edited by F. Tyrrell.

In cases of direct inguinal hernia, the coverings of the sac are the skin and superficial fascia, the fascia of the cord, the conjoined fibres of the internal oblique and transversalis (if they be not ruptured), together with the fascia transversalis. The cremaster muscle forms only a partial covering, near the external ring, for there the cord and the tumour come into contact; but they instantly diverge, one passing upwards into the abdomen, the other outwards in the course of the canal. The division of the different structures above enumerated is to be conducted on the same principle as in the oblique descent, but with a degree of caution the more as the tumour has a covering the less.

FEMORAL HERNIA.

606. *Progress of the intestine.*—When a portion of intestine passes into the femoral ring, it necessarily pushes before it that part of the peritonæum which lines the aperture, and, thus invested, descends into the tubular sheath sent down round the femoral vessels, from the fascia transversalis and iliaca, in other words, into the femoral canal. After descending for about an inch and a half, its progress downwards is arrested; and if the quantity of intestine protruded increases, the tumour turns forwards through the saphenous opening in the fascia lata. There its direction becomes altered again, as it is made to ascend obliquely inwards, lying in front of the iliac portion of the fascia lata (its falciform process), and even of Poupart's ligament; so that it forms, by its different turns, a curve whose concavity looks upwards.

Having thus described the progress of the intestine, we are prompted to inquire what are the circumstances in the structure of the parts through which it passes which determine these changes in its direction? Having descended to the point above indicated, the tumour is checked by the narrowing of the tube in which it is enclosed. This, though wide above, where its inner border is separated at a considerable interval from the femoral vessels, gradually contracts, so as soon to come into close contact with them; and where it does so, it must become intimately connected with them by the *vasa vasorum.* The lower border of the saphenous opening is also closely applied to the sheath of the vessels in this situation; and as the pubic portion of the fascia lata passes behind, whilst the iliac lies in front of it, any extraneous substance that may pass down in the sheath would be constricted by that arrangement of the fascia, even if the connexion between the vessels and the sheath were not sufficient to produce such an effect. These causes limit the descent of the intestine, and determine its passage forwards through the saphenous opening, where comparatively little resistance is given.

But, it will be asked, why does the hernia turn upwards? why does it not rather descend in front of the thigh, lying between the skin and the fascia lata, more especially as, from its exit out of the abdomen, down to its first turn, it had been lying on the pubic portion of that fascia? The impediment to its descent in that way is produced, partly by the manner in which the superficial fascia is connected to the margin of the saphenous opening, but chiefly by the superficial epigastric vessels which run on its surface. With these the tumour comes into contact, after emerging through the opening, and though, by the firmness of their connexion with the deep vessels, they resist its descent, they offer no obstacle to its ascent, so that during this part of its course it necessarily passes up between the superficial fascia which lies in front of it, and the fascia lata lying behind.

607. *The taxis—principle of.*—To restore to its natural situation an intestine so placed, it becomes necessary to make it retrace its steps, as it were, describing successively, but in a retrograde course, the different turns it had made in its passage. With this view, after having adjusted the body so as to relax the abdominal muscles, and to take off all tension from Poupart's ligament, the patient being placed with the affected side close to the side of his bed, the surgeon draws the tumour downwards into the hollow at the upper part of the thigh, so as to bring it opposite the saphenous opening. This being done, it should be pressed backwards, as if into that aperture, and upwards, with a slight inclination outwards, so as to avoid any impediment that may be presented by Gimbernat's ligament. Should these and the other usual expedients fail, the operation must be resorted to, even still more speedily than in cases of inguinal hernia.

Femoral hernia—operation.—When commencing the operation, the first step (after the body has been properly placed) consists in dividing the skin by a transverse incision carried over the middle of the tumour from one side to the other, parallel with Poupart's ligament, and of course below it. This incision may be made by pinching the skin into a fold parallel with the femoral vessels, and cutting down to its base; after which, when allowed to return to its natural situation, it will be found divided in the extent and direction above indicated. This should be met at right angles by another incision, begun about an inch and a half above the femoral arch, so that both together shall stand thus ⊥. Many surgeons, it may be observed, commence with a crucial incision. Dupuytren usually does so. Sabatier discountenanced the practice, through a fear that if the vertical incision were carried below the horizontal one, so as to form a cross, the saphenous vein might be wounded. If the tumour be very small, such an accident may arise from prolonging the incision below the middle part of it; but when it increases, and comes forward, through the saphenous opening, it lies on a plane anterior to the vein, which therefore is out of all danger. In the transverse incision through the skin, the superficial epigastric artery is divided, but that is of little consequence. The angular flaps of integument having been reflected, the superficial fascia becomes exposed, and should be divided to the same extent. It is much thicker than where it forms a covering for inguinal hernia, and contains, moreover, some of the superficial lymphatic glands. The tubular sheath of the femoral vessels, or *fascia propria*, next comes into view, which is to be cautiously divided by pinching up a small piece between the blades of the forceps, and cutting it off close to their points, thus making an aperture sufficient to admit a director. When the fascia propria is divided, the hernial sac is, in most cases, still obscured by that thick lamella of cellular tissue which lies across the femoral ring, and has been pushed down before the peritonæum, as the hernia descends. It is scarcely necessary to add, that this also must be divided; after which, whilst the proper sac, or peritonæal covering of the intestine, is being opened, the same precautions should be observed that have been already suggested when describing the operation for inguinal hernia.

The stricture—seat of.—When the contents of the sac are exposed, the operator has to divide the stricture, which obviously includes a consideration of the place at which the division should be made, and the manner of making it. The finger being introduced into the sac, and passed upwards along its anterior and inner side, for the purpose of ascertaining the seat of the stricture, it will be found, according to the testimony of our highest authorities, either at the arched border of the saphenous opening, at the edge of Poupart's ligament, or in the neck of the hernial sac. Should a stricture be found at the border of the opening in the fascia lata, a bistoury may be introduced on the finger, and its division effected by directing the edge of the instrument obliquely upwards and inwards. This part can be the seat of stricture only when the tumour is sufficiently large to turn forwards and upwards; and it not unfrequently happens, that though it be divided, still the reduction of the intestine cannot be effected. The stricture must then exist higher up, in one or other of the situations above indicated, to remove which, different modes of proceeding have been recommended, all, however, having a common object, viz. to widen the opening through which the intestine had escaped in the first instance, and which it necessarily must repass whilst it is being restored. The anterior boundary of the femoral ring being Poupart's ligament, and the internal one that of Gimbernat, the proposed end must be attained by the division of one or other. Sir Astley Cooper is of opinion that Gimbernat's ligament cannot be the seat of stricture; for "if strangulated femoral hernia be examined in the dead body, and that ligament cut through, the hernia is not liberated by such a division."

The stricture—division of.—If it be on these grounds concluded that the stricture is situated at the border of Poupart's ligament, or in the neck of the sac, the same incision will necessarily divide both. But in what direction should it be made? This question must be determined by a reference to the position of the vessels or parts which lie contiguous to the margin of the ring. If the incision were directed upwards in a male subject, the spermatic vessels and vas deferens must be wounded, should it be carried beyond a very few lines. In the female, the round ligament only would be endangered, which is of comparatively little importance. To avoid these consequences, Sharpe recommended the edge of the bistoury to be inclined upwards and outwards, by which means its direction will be parallel with that of the cord; but then the epigastric artery lies exactly before it. Though this fact would seem rather decisive against adopting the practice, Dupuytren prefers it to any other, and no vessel appears to have been wounded in any of his operations; doubtless from the fact, that it is only necessary to divide a few fibres of the ligament. One point then remains, in which the stricture may be divided without risk, viz. by inclining the edge of the bistoury, after it has been introduced, obliquely *upwards and inwards.* On this but one contingency rests, and that an extremely remote one, namely, when the obturator artery arises from the epigastric in such a way that, as it descends into the pelvis, it runs along the anterior and inner side of the ring. For full information on this important subject the reader will consult the following works:—SIR ASTLEY COOPER'S *Treatise on the Anatomy and Surgical Treatment of Hernia;* LAWRENCE *on Ruptures;* SIR A. COOPER'S *Lectures on Surgery,* edited by F. TYRRELL; and SCARPA *on Hernia.*

SURGICAL ANATOMY OF THE PERINÆUM.

The subject is placed on its back, and drawn to the edge or end of the table; its foot is tied to the hand at each side, and the knees held apart. A curved staff or catheter is introduced into the bladder. The penis and scrotum are drawn up towards the abdomen, so as to expose the perinæal space. The first steps of the dissection have been already pointed out (see Dissection, sect. 504). The superficial fascia, its structure, attachments, and relations, will also be found described with sufficient detail, as well as the perinæal muscles. These things being premised, we now proceed to the structure which comes next in order, viz. the deep perinæal fascia.

608. The *deep perinæal fascia* is a thin, yet firm membrane, which fills up the interval between the rami of the ossa pubis and ischii, and is thereby rendered triangular in its form. In its mode of attachment and general characters it presents some similitude to the obturator fascia, which fills the foramen of that name. It should be observed, that this structure has been variously denominated by different writers. Camper* and Douglas named it *ligamentum triangulare.* M. Velpeau† has devised or adopted the term *recto-vesical aponeurosis.* The terms ligament, tendon, aponeurosis, and fascia, appear to be ordinarily used, as if they were synonymous. It would be well to confine each of them to particular forms of structure. A ligament is properly a fasciculus of tendinous fibres connecting bones, and for the most part entering into the formation of joints; a tendon is the cord-like prolongation of a muscle; an aponeurosis is the expanded fibrous lamella prolongated from a broad muscle; whilst the term fascia, in strictness, denotes a

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* Fasciculi Anatomico-pathologici.

† Anatomie des Regions.

membrane serving to invest parts, or to support them. In this sense we here apply the term to the fibro-cellular lamella which fills up the outlet of the pelvis, and assists in supporting its viscera: it is also called the deep fascia, to distinguish it from the superficial one already noticed. (See sect. 504.)

The deep perinæal fascia is attached on each side to the osseous boundaries of the perinæal space, which thus determine its form; and, if examined beneath the pubic arch, will be found to consist of two lamellæ, which, on approaching the base of the sub-pubic ligament, separate, one passing on its cutaneous, the other on its pelvic surface, where they terminate by gradually becoming thin and cellular. Where the membrane is strained across the interval between the bones, it at first sight appears to terminate by a lunated border, whose concavity looks towards the rectum; but we find that its continuity is not interrupted at this point, as it can be traced downwards round the margin of the rectum, and on the levator ani, gradually, however, becoming thin and indistinct.

609. *Urethral canal.*—About half an inch below the base of the sub-pubic ligament, and, therefore, an inch below the arch, the deep fascia presents a foramen, or rather forms a canal, for the transmission of the urethra. If the latter be drawn forwards, it will be found to be invested by a tubular prolongation derived from the margin of the foramen, and continuous with the perinæal or external lamella of the fascia. A similar prolongation is reflected backwards from the posterior or pelvic lamella which invests the membranous and prostatic portions of the canal, and extends as far as the neck of the bladder. When the parts remain undisturbed, the surface of the fascia is quite flat; and if the urethra be cut across close to it, the aperture will be found barely sufficient to transmit it. But if the penis be drawn obliquely upwards, the fascia is rendered tense, and convex forwards, by means of the traction exerted on it through the medium of its tubular prolongation. Should the experiment be then made of cutting off the urethra close to the fascia, the foramen will be found much wider, for the tube had been previously rendered, as it were, trumpet-shaped, and so it will be when the urethra is rendered tense during the introduction of a catheter.

It may now be observed that the urethra, whilst the penis remains pendulous, forms two curves, the concavity of one looking down towards the perinæum, that of the other up towards the pubic arch. The first of these is owing to the fact, that the penis is attached on each side of the arch of the pubes by its crura, and by its triangular ligament to the symphysis, from which it hangs downwards, carrying the urethra with it. From the angle thus formed by the body of the penis with the fore part of the pubes, the urethra has to descend about an inch, to get to a level with the urethral foramen in the perinæal fascia; and, finally, having passed through the foramen, it inclines a little upwards behind the symphysis. This latter curve is very trifling in the adult, but is considerable in the young subject, owing to the position of the bladder. When, preparatory to the introduction of a catheter, the penis is drawn upwards on a line with the abdomen, the first or anterior curve no longer exists, and so the canal presents but a single curve, corresponding with that of the instrument.

610. *Catheterism.*—If the integument, superficial fascia, and muscles, be removed from the penis and perinæum, we can observe what takes place on the introduction of a catheter. No impediment occurs during its passage through that part of the tube which corresponds with the corpus spongiosum, for there it is supported by the body of the penis, and is also quite straight. But where it corresponds with the bulb, it is comparatively unsupported, and also is slightly dilated at its lower surface. On arriving close to the perinæal fascia, should the point of the catheter deviate to either side, or be elevated or depressed too much, it will miss the foramen, carrying the urethra with it, and so the latter will be pinched between the margin of the foramen and the instrument. If, in such a position of the parts, force be used, or if the catheter be depressed, with a view to make it correspond with the curve of the urethra, the latter must be torn through, or considerably injured. A catheter in its construction resembles an angular lever, though not intended to act as such; but it virtually becomes such, if, after its progress is impeded, and it is thereby rendered fixed, an effort be made to depress the handle, for then the beak is made to move in the opposite direction, and will readily tear through the urethra. The effect of drawing the penis upwards may be exemplified in this way: when the catheter has reached the bulb, (the urethra and perinæal fascia being fully exposed,) if it deviates to either side, the point will be observed to catch

on the margin of the foramen; but if the urethra is drawn upwards, the impediment will be removed by the widening of the aperture in the foramen.

It has been contended rather strenuously by some persons, that the direction of the urethra becomes horizontal, and its canal straight, when the penis is drawn directly forwards. It will, however, be found, that when the penis is so placed, the urethra has to descend nearly an inch to reach the urethral foramen, after which it turns somewhat upwards. Moreover, the part of the urethra between the root of the penis and the neck of the bladder will be found loose and relaxed, no matter with what degree of force the penis be drawn forwards, for that will affect only the part of the urethra which corresponds with the body of the organ, as must be evident when the attachments of the latter to the bones, by its suspensory ligament and crura, are considered. The tension will, by these attachments, be confined to the spongy portion of the canal, and cannot be propagated thence to the bulbous or membranous. This constitutes the principal impediment in the use of straight catheters.

611. *Different modes of operating—Historical sketch of.*—Having noticed the boundaries of the perinæum considered as a surgical region, and having enumerated the different structures included within it, as well as their mutual relations, we may now observe that, narrow as this space is, there is scarcely a direction possible to be conceived in which it has not been traversed by incisions made to open a way through it into the bladder for the extraction of calculi.

The operation of Celsus.—Taking these different modes of proceeding in their historical order, the first we find recorded is that of Celsus.* The patient was placed in the lap of an assistant, who was required to keep his legs bent so as to expose the perinæum. If the patient was large, or very robust, two assistants were strapped together by the thighs, and each held the leg next to him, whilst the body was supported between them. The surgeon passed the index and middle fingers of his left hand into the rectum, with a view to press against the stone and force it forwards into the neck of the bladder, making it thereby prominent in the perinæum. This being done, he made a lunated incision about midway between the margin of the anus and the bulb of the urethra, the concavity of the curve looking down to the former, its extremities being directed towards the ischia—"cornibus ad ischia spectantibus." In this way he cut down upon the stone, and sought to push it through the wound; but if that did not succeed, he used a hook to assist in its extraction. This mode of operation was subsequently called "cutting on the gripe;" and from the fewness of the instruments required for its performance, it was described as the *apparatus minor*, to distinguish it from another in which several were employed. The parts divided in the incisions were—the skin and superficial fascia, part of the fibres of the accelerator muscles, and the transverse muscles; finally, the prostatic part of the urethra, the lower half of which was thrown down in the form of a flap. It is not at all unlikely that the urethra was in many cases cut across, and severed altogether from the bladder. Heister says, that the stone was made prominent at the left side of the perinæum, and that an oblique incision was then made down upon it. The line of incision marked in his plate corresponds exactly with that of the lateral operation as now performed; so that he must have taken his delineation from the mode of operation practised in his own time, and not from that described by Celsus.

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* Lib. vii. cap. 26.

The operation of Romanus.—After the revival of letters, when every dictum of Hippocrates passed for doctrine, a method of operation was devised by one Johannes Romanus, founded on a dogma of the father of physic, "that wounds of membranous parts do not unite." Its description was subsequently given by one of his disciples, named Marianus Sanctus, from which circumstance it was afterwards called "sectio Mariana," but is better known as the *apparatus major*, from the variety of instruments it required. When the perinæum was exposed, a grooved staff was introduced, and an incision made with a razor along the middle line, extending from beyond the bulb to within a finger's breadth of the margin of the anus. A second incision laid open the bulbous part of the canal, which concluded the cutting part, as all the rest was to be done by dilatation; for though the rules of art forbade the division of membranous parts, they laid no injunction against their being stretched. Hence the operation was of a mixed character, founded partly on the necessity of resorting to incisions, and partly on the equally imperative necessity of deferring to authority. When the urethra was laid open, dilators were introduced, in order to distend the canal sufficiently to admit the forceps; but, as may be concluded from a consideration of its structure and width, laceration was the immediate result, and not simple dilatation. The after consequences may be readily inferred.

Operation of Frère Jacques.—At a subsequent period, a method of operation was projected and carried into execution by a monk, named Frère Jacques, who appears to have been altogether unacquainted with anatomy, and even otherwise illiterate, and yet his plan must be admitted to have paved the way for the introduction of that which is now most generally employed. Having introduced a common catheter (not grooved), he therewith caused the bladder to be made prominent in the left side of the perinæum: he, in the next place, inserted a long bistoury between the anus and tuber ischii, but nearer the latter; and, directing it upwards and forwards, he entered the bladder at its side, and cut through the neck, "without injuring* any other part of the urethra." When the operation was performed on the dead subject, it was found that "the integument having been divided for about two fingers' breadth, the wound next passed between the accelerator and erector muscles without injuring either, and had penetrated the neck of the bladder, and part of its body, for about an inch."† This was subsequently termed the *lateral operation,* both because the incision was parallel with the side of the perinæal space, and also because it opened its way into the side of the bladder. This plan was acted on, but modified and improved, by Ravius, or Raw, in Holland, and by Cheselden in this country, both of whom used a grooved staff.

Cheselden's operation.—Mr. Cheselden, in his first operations, entered the bladder at the side, and then divided its neck, by drawing the scalpel from within outwards, or towards the surface. It must be very difficult to extract, without laceration, a stone of any size through an incision placed so deeply, and corresponding with the side, and not with the most depending point of the bladder: for this reason, as well as from its having been followed by sloughing of the cellular substance round the rectum, caused by infiltrations of urine, this method was soon abandoned. An objection of another sort may also be taken to it, derived from a consideration of the direction in which the incision in the bladder is made. The point of the scalpel is entered at a part comparatively unsupported and movable, and is thence directed towards the neck, which, by means of its attachments, is held fixed,—a mode of proceeding which is contrary to an obvious principle in the making of incisions. This Cheselden effectually remedied, by entering his scalpel into the groove of the staff, where it lies in the membranous part of the urethra, and passing it from before backwards, so as to divide the prostate gland and neck of the bladder.

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* Heister, System of Surgery.

† Ibid.

The operation, as devised by this eminent surgeon, and practised at the present day, may be performed as follows (attention is here confined to the operative part exclusively, all other details and preliminaries being foreign to our present purpose):—A grooved staff, corresponding in size with that of the urethra, is in the first place introduced, and so placed that its concavity lies close beneath the pubic arch, whilst its convexity is turned somewhat towards the left side of the perinæum. The edge of the scalpel is then laid on the skin, close to the left side of the raphé, at about fourteen lines before the margin of the anus, and is thence drawn downwards and outwards to the interval between the margin of the anus and the left tuber ischii, inclining a little nearer to the latter; this divides the skin and superficial fascia. The second incision, commencing a quarter of an inch, or a little more, according to the size of the bulb, below the upper end of the first, is carried downwards in the same direction and extent, and so divides the lower fibres of the accelerator muscle, the transversus perinæi muscle and artery, with part of the levator ani and deep perinæal fascia. The staff should now be sought for at the upper angle of the incision; if the bulb be large, it will be necessary to press it aside with the index finger of the left hand. The point of the scalpel being elevated, by depressing its handle, and throwing the hand a little back, it is made to enter the groove of the staff, its lodgement therein being ensured by moving it slightly from side to side, and then is passed along the groove, so as to lay open the membranous part of the urethra. When this has been effected, the operator draws downwards to himself the handle of the staff (its concavity being held securely beneath the pubic arch), by which means its beak is made to move upwards and backwards, and thereby removed from the rectum. Whilst this is being done, the scalpel (previously lateralised, so that the direction of its edge shall correspond with that of the external incision,) is made to slide along the groove, dividing in its passage the prostatic part of the urethra and of the neck of the bladder. After this has been completed, the scalpel is withdrawn a little, and carried obliquely downwards in the direction of the first incision, so as to divide any septa that may lie across the wound, which usually consist of part of the fibres of the levator ani, and of the transversus perinæi, if not severed in the second incision. The advantage, or rather the necessity, of freely dividing the membranous part of the urethra, previously to depressing the staff, has been put in a very clear point of view by Mr. Colles:—"If you have entered your knife into the urethra high up in the perinæum, and, while the point of the knife is lodged there, should depress the staff, and attempt the division of the prostate, you will have to make it describe a portion of a circle at the same time that it is dividing very resisting parts."

The operation of Celsus revived.—M. Chaussier in his lectures frequently commented on the curved-lined incision through the perinæum indicated by Celsus, and appears to have sanctioned this method of operating. Two of his pupils made it the subject of their theses; but it does not appear to have been reduced to practice, or to have met with any general approval as to its principle. Some years ago M. Dupuytren conceived it practicable to modify and improve the method of Celsus so as to render it safe and easy of execution. The principal difficulty to be got over is that of making the final incision through the prostate gland exactly to correspond with the curved direction of the first and second incisions through the skin, muscles, and fasciæ. When this is attempted with the scalpel or lithotome, two separate incisions must be made, one along the left side, the other at the right, the staff being inclined alternately each way so as to serve as a guide to the cutting instrument. In making the second incision the operator is very liable to direct it so as to cut a narrow angular flap in the prostate rather than the broad segment which is intended. To avoid these inconveniences, M. Dupuytren performs the section of the prostate with a double-bladed lithotome caché, so constructed that the blades by being curved in the direction of their planes shall, when pressed out from their sheath, cut obliquely outwards and downwards.

Dupuytren's operation (la taille médiane périnéale; sectio bilateralis).—The method of proceeding is as follows:—The patient is placed in the usual position, and a grooved staff is introduced into the bladder, which is entrusted to an assistant, who at the same time holds up the scrotum. The operator renders the skin of the perinæum a little tense by pressing it down with the fingers of his left hand placed at the anus, and then with a scalpel a curved incision is made through the tegument, commencing at the right side between the ischium and the anus, and terminating at the corresponding point at the opposite side. The concavity of the curve thus described looks downwards to the anus, and its convexity upwards to the bulb of the urethra, its centre being about five or six lines above the former point. A second incision is made in the same direction and to the same extent through the muscles and the deep fascia. In the next place the operator, with the index finger of his left hand, feels for the curve of the staff in the urethra at the top of the wound, and there he enters the point of his scalpel. When secure of its position, he runs it in the groove from before backwards, for four or five lines, so as to divide the membranous part of the urethra. This being effected, the point of the double lithotome is placed in the groove of the staff, its concavity being turned up towards the pubic arch; then the operator, taking hold of the handle of the staff, draws it down towards him and passes the lithotome back into the bladder. The staff is withdrawn, and the lithotome turned so that its concavity shall look downwards. Its blades are expanded to the required extent, and the instrument drawn steadily outwards, its handle being at the same time a little depressed, so that it is made to cut outwards and downwards. In this way the prostate gland and the neck of the bladder are divided at each side, and a lunated flap, composed of the lower segment of these structures, is formed. This will give sufficient space for the easy extraction of a calculus, unless it be of unusually large size, or the pubic arch be very narrow. This operation is termed "bilateral," not only because the first incision extends into both sides of the perinæal space, but because both sides of the prostate gland are incised by a double-cutting instrument. In this method of proceeding no risk is incurred of wounding the rectum, and the pudic arteries can only be endangered by making the blades of the lithotome spread out to an extent altogether unnecessary.

The *recto-vesical* operation consists in laying open the bladder in the middle line by cutting from below upwards, beginning in the rectum, and so laying the two cavities into one. I mention it merely because it has been practised by M. Sanson in Paris, and M. Vacca Berlingieri in Pisa. It is not sanctioned by any surgeon in this country, nor is it likely to meet with much approval, as it contravenes one of the first principles of surgery, which prescribes that we are not to wound any important parts which can be avoided.

Lithotomy—its difficulties.—This brief historical notice shows us at one view the various routes that have been chosen at different times to reach the bladder through the perinæum: narrow as the space is, it is surrounded with parts on every side that must be avoided. The rectum lies beneath the line of incision, the pudic artery outside it, and the artery of the bulb above it; and again, whilst passing into the bladder, the incision must be so made as to avoid the ejaculatory ducts. Notwithstanding these difficulties, if the parts were unvarying in their relations, the execution of the operation might be made comparatively easy, by performing it a number of times on the dead subject. But, in addition to the complexity of the lines of incision, and their close contiguity to parts which should not by any means be wounded, there is another source of difficulty which is seldom attended to, and which arises from the fact, that the depth, as well as the dimensions of the perinæal space, vary in different individuals far more than could at first sight be supposed. It is usually said, that the space is included within three lines, each three inches long, so that it is an equilateral triangle; and, as the operation is now performed, the left lateral half of that triangle is alone interested. The extent of the space here indicated is more than the average. Professor Dupuytren measured the distance between the tuberosities of the ischia in twenty-three subjects, taken indiscriminately from the dissecting rooms, and found that in some it was not more than two inches, but in others was as much as three and a half. Again, by placing one branch of a pelvimeter at the surface of the perinæum, and the other at the neck of the bladder, it was ascertained that the distance between them, or, in other words, the depth of the perinæum, was in some instances only an inch and some lines, in others four inches and a quarter.